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DE PLANTIS TOXICARIIS E MUNDO NOVO TROPICALE COMMENTATIONES XXVI

ETHNOPHARMACOLOGICAL NOTES ON THE FLORA OF NORTHWESTERN SOUTH AMERICA

RICHARD EVANS SCHULTES

This series of papers has been offered in an attempt to stimulate interest on the part of pharmaceutical researchers in investigation of the wealth of ethnopharmacological knowledge of the incredibly rich flora of the northwesternmost part of South America, especially of the Amazonian sector of this region.

Botanical and ethnobotanical studies of the flora of this part of South America have been under way now for at least a century and a half. Yet it is only during the last few decades that ethnobotanical exploration and laboratory studies of the plants have been carried out from pharmacological and chemical points of view. With the highly sophisticated chemical techniques now available, it is even more imperative to take advantage of ethnobotanical knowledge of peoples who, for many millenia, have lived in close association with their ambient vegetation.

We should realize that the Plant Kingdom is vastly more complex and extensive than it was once thought to be—even as recently, for example, as in the 1920s. Some investigators now believe that there are at least half a million plant species to be investigated. Only a relatively few species of this assemblage of different chemical factories have ever been examined—and that only superficially and for specific compounds, such as alkaloids.

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It is becoming increasingly apparent that the indigenous materia medica of the northwestern Amazon represents an untapped assemblage of plants, many of which might be of interest to pharmacological and phytochemical scientists. The flora of the Amazon Valley — undoubtedly surpassing 73,000 species — represents one of the last preserves to be destroyed by man. This destruction is progressing at a prodigious rate, especially in the eastern part of the basin. With acculturation or extinction of the aboriginal populations, an extensive ethnobotanical survey of lore and practice extending at least over 5000 years will have been totally lost.

A recent — and, from several points of view, an outstanding — phytochemical study of one group of plants, based in great part on ethnopharmacological information, strongly supports the value of the interdisciplinary approach: the collaboration of the chemist and pharmacologist with the botanist and ethnobotanist. I refer to Gottlieb's recent article in the *Journal of Ethnopharmacology* (Gottlieb, O.: *Journ. Ethnopharm.* 1 (1979) 309–323). This review points out that there is chemical support for a number of the native uses of various myristicaceous plants of the Amazon as hallucinogens and arrow poisons as well as in the treatment of infected wounds and skin troubles.

Voucher specimens for the following notes are preserved in the Economic Herbarium of Oakes Ames and in the Gray Herbarium, both of Harvard University, in the Herbario Nacional de Colombia, Bogotá, or in several of these institutions. Several of the collections mentioned are preserved in the New York Botanical Garden herbarium.

The families are arranged in accord with the Engler and Prantl system and the genera alphabetically under the families.

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Lycopodiaceae

Lycopodium cernuum *Linnaeus*, Sp. Pl. (1753) 1103.

Colombia: Comisaría del Amazonas, Río Amazonas, vicinity of Leticia. August 29–September 12, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24038.*

A Dragendorff spot-test for alkaloids was positive for this common species of *Lycopodium.*

Alkaloids have recently been detected in about a dozen species of Lycopodiaceae. Nicotine and quinolizidine bases account for most of the lycopodiaceous alkaloids (Tyler, V. E.: *Lloydia* 24 (1961) 58).

Araceae

Anthurium eminens *Schott* in Oestr. Bot. Wochenbl. 5 (1855) 273.

Ecuador: Napo, Río Aguarico, Dureno. October 2, 1966. *H. V. Pinkley 471a, 471b;* June 20, 1966. *Pinkley 288.*

The Kofán names of this *Anthurium* are *insindevo-se-he ′-pa; misi-se-he ′-pa; ain-se-he ′-pa.*

The field notes for this aroid state merely "medicine for animals" *(Pinkley 471a* and *b)* and "medicine" *(Pinkley 288.).*

Anthurium Jenmanii *Engler,* Pflanzenr. 4, Fam. 23b (1905) 72.

Ecuador: Napo. Río Aguarico, Dureno. June 21, 1966. *H. V. Pinkley 290.*

According to the collector, the Kofáns crush all parts of the plant in hot water and apply it to relieve "stiff neck." The native name is *caridi-se-he ′-pa.*

Anthurium scolopendrinum *Kunth,* Enum. Pl. 3 (1841) 68.

Ecuador: Napo, Río Aguarico, Dureno. February 22, 1966. *H. V. Pinkley 134.*

This plant is boiled, and the resulting tea is used as a mouth rinse for toothache. The Kofán name is *chi-pi-ri-fambi-cho.*

Anthurium tenuispadix *Engler,* Pflanzenr., 4, 23b (1905) 73.

Ecuador: Napo, Río Aguarico, Dureno. June 3, 1966. *H. V. Pinkley 245.*

A gargle is prepared from the crushed leaves for treatment of sore or swollen throat. The Kofán name is *ti-sha-va-wo-cho-se-he ′-pa.*

Caladium bicolor *(Ait.) Ventenat,* Jard. Cels. (1800) t. 30.

Ecuador: Napo, Río Aguarico, Dureno. "Cultivated." June 27, 1966. *H. V. Pinkley 333.*

According to field notes, the leaf is placed in the nostrils of dogs "to make them better hunters for *saquira* (wild pig)."

Dieffenbachia obliqua *Poeppig et Endlicher,* Nov. Gen. ac Sp. 3 (1845) 90.

ECUADOR: Napo, Río Aguarico, Dureno. January 1, 1966. *H. V. Pinkley 88.*

Field notes accompanying this specimen indicate that the plant is "poisonous to touch, causing itching." The Kofán names are *to ′-vo* and *akie-ega.*

Dracontium longipes *Engler* in Engler, Bot. Jahrb. 37 (1905) 122.

PERU: Departamento de Loreto, Ushpacano, 2 hours from Iquitos. February 2, 1968. *F. Tina et M. Tello 2054.*

This aroid is called *jergon sacha* in Amazonian Peru. The field notes accompanying the specimen read: "For snake bite. Put over the fire one teaspoon of *jergon sacha* with a little water for 2 minutes, then take off the fire and apply of the snake bite place three times a day."

Dracontium Trianae *Engler,* Pflanzenr. 4, Fam. 23c (1911) 44.

ECUADOR: Napo, Río Aguarico, Dureno. December 30, 1965. *H. V. Pinkley 60a, 60b.—Same locality. June 21, 1966. Pinkley 294.*
PERU: Departamento de Loreto, vicinity of Iquitos. July 1967. *R. Martin, T. Plowman et C. Lau-Cam 1661.*

The Kofáns of Ecuador, who cultivate this aroid, know it as *shi-shi-tu-she-se-he ′-pa* and boil the tuber to prepare a decoction drunk to treat diarrhoea.

In Peru, the tuber is ground into a paste and wrapped in leaves of *Calathea.* When warmed in a fire, the paste is applied to snake-bite as a plaster.

Xanthosoma conspurcatum *Schott,* Syn. Aroid (1856) 61.

ECUADOR: Río Aguarico, Dureno. June 26, 1966. *H. V. Pinkley 329.*

The Kofáns, who call this plant *to ′-vo,* assert that it is "poisonous to touch."

PONTEDERIACEAE

Pontederia cordata *Linnaeus,* Sp. Pl. (1753) 288.

COLOMBIA: Comisaría del Putumayo, Mocoa. Camino de Herradura Antiguo y Río Rumiyaco. Alt. 700–850 m. "N. v. *amarón borrachero"* Planta acúatica, Flores blancas. Se usa para quitar parálisis fasciales." October 10, 1965. *H. García-Barriga, Y. Hashimoto et M. Ishikawa 18685.*

The vernacular name *amarón borrachero* indicates that *Pontederia cordata* either possesses intoxicating principles or is employed as an additive to a narcotic preparation made basically from *Banisteriopsis Caapi.* In view of the probable lack of toxic principles in this species (Hegnauer, R.: *Chemotaxonomie der Pflanzen* 2 (1963) 419–421), the latter use is the more likely of the two possibilities.

According to the collectors, *Pontederia cordata* is employed to relieve facial paralysis, but the manner of its use is not specified.

AMARYLLIDACEAE

Eucharis amazonica *Linden* in Ill. Hort. 28 (1881) 30.

ECUADOR: Napo, Río Aguarico, Dureno. February 7, 1966. *H. V. Pinkley 105.*

Amongst the Kofáns, the whole plant (including the bulb) is boiled and steeped to prepare an emetic tea. Pinkley reports that "this insures greater accuracy in using the blow gun while hunting monkeys." The Kofán name is *kon-si-achipa-cho.*

An alkaloid — lycorine — has been isolated from *Eucharis grandiflora* Planch. This constituent appears to be widespread in the family (Hegnauer: loc. cit. 2 (1963) 58; Raffauf, R. F.: *A Handbook of Alkaloids and Alkaloid-containing Plants* (1970).

HAEMODORACEAE

Schiekia orinocensis *(HBK.) Meissner,* Plant. Vasc. Gen. 2 (1842) 300.

COLOMBIA: Comisaría del Putumayo, Río Sucumbios (San Miguel). April 7–8, 1942. *R. E. Schultes 3568.*

Amongst the Kofán Indians, the stem of *Schiekia orinocensis* is employed as a soap. It is known by the Spanish name *jabón* ("soap").

Nothing is known of the chemistry of *Schiekia.*

ORCHIDACEAE

Dichaea muricata *(Sw.) Lindley,* Gen. et Sp. Orch. Pl. (1833) 209.

ECUADOR: Napo, Río Aguarico, Dureno. 1966. *H. V. Pinkley 526.*

A wash prepared from this orchid is valued by the Kofán Indians for treating eye infections, probably conjunctivitis which is common in the region. The Kofán name of the plant is *shahasi-sehe ′-pa.*

No chemical studies apparently have been done on *Dichaea.*

Oncidium pusillum *(L.) Reichenbach fil.* in Walpers Ann. Bot. 6 (1863) 714.

ECUADOR: Napo, Río Aguarico, Dureno. 1965. *H. V. Pinkley 11.*

The Kofán Indians of the Colombo-Ecuadorian part of the westernmost Amazon treat lacerations with a wash prepared by boiling this plant in water. The Kofáns call the plant *atii ′-pa-kashaikie-si-sehe ′-pa.*

Oncidium pusillum has apparently not been checically studied.

Recently a new name for this well known orchid has been proposed: *Psygmorchis pusilla* (L.) Dressler et Dodson. Believing that this new genus *Psygnorchis* is based upon trivial characters, I prefer to employ the widely and time-honoured binomial *Oncidium pusillum.*

Phragmipedium ecuadorense *Garay* in Harling et Sparre, Fl. Ecuad., Orch., no. 9, pt. 1 (1979) 15.

ECUADOR: Napo, Río Aguarico, between Dureno and Santa Cecilia. "Growing on vertical cliff about 8 ft. above river. Flower greenish. Plant extremely rare, according to the Kofáns." November 1966. *H. V. Pinkley 553.*

This orchid is boiled in water to prepare a tea taken for "stomach trouble." The Kofán names are *shatifa-se ′he ′-pa* and *topa-sé-he ′-pa.*

Moraceae

Pourouma Cucura *Standley et Cuatrecasas* in Fieldiana, Bot. 28, no. 1 (1951) 211.

Colombia: Comisaría del Vaupés, Río Apaporis, Soratama (above mouth of Río Kananarí) and vicinity. January 1952. *R. E. Schultes et I. Cabrera 19835.*

The bark of *Pourouma Cucura* is boiled for several hours in water to prepare an infusion which is vigourously rubbed on aching joints and other areas of the body affected with rheumatic-like pains and swellings. This practice is common amongst the Taiwano Indians of the Río Kananarí, who know the plant as *ma-he'-ne-ka-pa.*

There appear to have been no chemical studies made of the genus *Pourouma.* The major importance of the genus to the Indians of the northwest Amazon centers on *P. cecropiaefolia* Martius, a cultivated tree yielding an edible grape-like fruit.

Piperaceae

Lepianthes umbellatum *(L.) Rafinesque,* Sylv. Tellur. (1838) 84.
Pothomorphe umbellata (L.) Miquel, Comm. Phyt. (1840) 36.

Colombia: Comisaría del Putumayo, Río Guamüés, San Antonio. "Secondary growth. Herb 5–6 feet." September 5, 1966. *H. V. Pinkley 421.*

The Kofán Indians prepare an arrow poison of this plant alone (the bark of the lower stem and root is scraped and boiled) or mixed with other plant ingredients, especially for hunting monkeys and wild pigs. The Kofán name is *a-nama-he-se-he'-pa.*

This species has been employed as a strong diuretic in Brazil (Peckholt, T.: *Pharm. Rundschau* 12 (1894) 240, 285).

There appears to be no chemical constituent which would make the bark active as an ingredient of curare. Many piperaceous plants are employed as minor ingredients in preparing curares, but they are believed not to have themselves any active curare constituents. The report that *Lepianthes umbellatum* may be used with no admixtures as an arrow poison plant consequently acquires special significance.

The binomial *Pothomorphe umbellata* is more widely known as the name of this plant. The use of the generic epithet *Lepianthes* has been recently discussed by Howard (Howard, R. A.: *Journ. Arn. Arb.* 54 (1973) 380 ff.).

Peperomia glabella *(Sw.) A. Dietrich* var. **melanostigma** *Dahlstedt* in Kgl. Sv. Vet. Akad. Handl. 33, pt. 2 (1900) 122.

COLOMBIA: Comisaría del Putumayo, Mocoa and vicinity. December 3-7, 1942. *R. E. Schultes et C. E. Smith 2959.*

This herb is a supposed remedy for conjunctivitis when applied in the form of a decoction (Schultes: Rhodora 77 (1975) 165). It is widely used in the region of Mocoa, where this eye infection is often epidemic. The plant is locally known as *tre-gwen´* and *gwinan* in the Ingano-language and *flor de mal* in Spanish.

Peperomia macrostachya *(Vahl.) Dietrich* var. **nematostachya** *(Link.) Trealease et Yuncker,* Piperac. N. S. Am. 2 (1950) 661.

COLOMBIA: Comisaría del Vaupés, Río Kananarí, Cerro Isibukurí. "Epiphyte." March 8, 1951. *R. E. Schultes et I. Cabrera 13260.* — Río Vaupés, Mitú and vicinity. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24178.*

The leaves of this climbing epiphyte are boiled, and the resulting tea is taken by elderly members of the Taiwano tribe to relieve difficulty in urinating. It is also said to be an effective febrifuge.

A Dragendorff spot test for alkaloids *(Schultes, Raffauf et Soejarto 24178)* was negative.

Peperomia serpens *(Sw.) Loudon,* Hort. Brit. (1830) 13.

COLOMBIA: Comisaría del Putumayo, Río Sucumbios, Santa Rosa. April 7–8, 1942. *R. E. Schultes 3589.*

The aromatic leaves and stems of this shrub are locally employed crushed and applied as a poultice to relieve the irritant and painful sting of the large conga ant *(Dinoponera grandis).* The Kofán Indians call the plant *oo-nov-se´-he´-pa.*

Piper Hostmannianum *(Miq.) C. DeCandolle* in DeCandolle, Prodr. 16, pt. 1 (1869) 287.

COLOMBIA: Comisaría del Amazonas, Río Amazonas, vicinity of Leticia. "Small bush. Leaves aromatic." August 29–September 12, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24018.*

In the Leticia region, a poultice of the crushed leaves is applied to warts in the belief that this hastens their disappearance. The plant is known as *cordoncillo,* a name applied to many species of *Piper* in reference to the inflorescence *(cordoncillo* = "shoe string").

Piper interitum *Trealease ex Macbride* in Field Mus. Publ. Bot. 13 (1936) 176.

PERU: Departamento de Loreto, Zapote, upper Río Purús. "Tree about 10 meters high. Lowland Forest." October 15, 1968. *L. Rivier 21.*

The Kulina Indians of eastern Peru, who call this plant *tetsi,* prepare a snuff from the dried leaves and roots. It is used as a "substitute" for tobacco.

There are indications from several native uses of species of *Piper* that the essential oils in this genus may have psychoactive properties.

Piper Schultesii *Yuncker* in Trealease and Yuncker, *The Piperaceae of Northern South America* (1950) 34.

COLOMBIA: Comisaría del Vaupés, Confluence of Ríos Macaya and Ajaju, Cerro Chiribiquete. May 15–16, 1943. *R. E. Schultes 5416.*

The Karijona Indians value this species, which they call *oo-ka'-ña-te,* in the treatment of bronchial ailments, most of which seem to be tuberculosis. A hot tea of the leaves and stem is drunk over a period of many days. This tea is a strong diuretic. Special trips are made to Chiribiquete and similar sandstone mountains in the area to procure leaves of the plant which are kept in dry condition for use; they conserve a strong pungency for many months.

POLYGONACEAE

Rumex obtusifolius *Linnaeus,* Sp. Pl. (1753) 335.

COLOMBIA: Comisaría del Putumayo, Valle de Sibundoy, Sibundoy. Alt. 2225-2300 m. May 29, 1946. *R. E. Schultes et M. Villarreal 7610.* — Same

locality. *"Lengua de vaca."* February 20, 1963. *P. J. Chindoy B. 97.* — Same locality. "Garden and waste places, very frequent. One or two most persistent, most frequent weeds in valley." April 1, 1963. *M. L. Bristol 704.* — Same locality. *"Lengua de vaca.* Open pasture; infrequent." May 8, 1963. *M. L. Bristol 969.*

The Kamsá Indians of Sibundoy employ the roots of *Rumex obtusifolius* in decoction as a strong laxative.

The roots contain 1,8-dihydroxynaphthaline (Hesse, O.: *Ann. Chem.* 305 (1896) 291).

Myricaceae

Myrica parvifolia *Bentham,* Pl. Hartw. (1846) 251.

Colombia: Departamento de Cundinamarca, Bogotá, Cerro above La Cita. May 10, 1946. *R. E. Schultes 7111.*

Bundles of the leaves and stems of this shrub are burned in huts of people living in the cool, humid highlands around Bogotá for the aromatic smoke which is believed to relieve congestion caused by the frequent pulmonary troubles of these people. This folk medicine use may perhaps be based on the presence of essential oils in the plant.

Leucoanthocyanines have been detected in one species of *Myrica* (Gibbs: *Chemotaxonomy of Flowering Plants* 3 (1974) 1396).

Menispermacae

Abuta splendida *Krukoff et Moldenke* in Bull. Torr. Bot. Club 68 (1941) 241.

Colombia: Comisaría del Amazonas, Río Miritíparaná, affluent of Río Guacayá, uppermost reaches. May 21, 1952. *R. E. Schultes et I. Cabrera 16569.*

The bark of the stem of this liana is the principal component of one of the arrow poisons prepared by the Yukuna Indians. The name of the plant in Yukuna is *wy-ya-pee '-ta,* in Tanimuka *nee-koo '-pa-roo.*

Curarea tecunarum *Barneby et Krukoff* in Mem. N. Y. Bot. Gard. 22 (2) (1971) 12.

BRAZIL: Estado do Amazonas, Río Cunhuá, Deni Indian village. November 28, 1971. *G. T. Prance, P. J. M. Maas, D. Woolcott et al. 16453.* COLOMBIA: Comisaría del Putumayo, Río Guamüés, Salvador. "Arrow poison." August–September 1963. *C. Naranjo et G. Wiederhold 16.* Comisaría del Vaupés, Río Macaya, vicinity of Cachivera del Diablo. "Said to have been used formerly by Karijona Indians in arrow poisons. Vine. Fruits yellow, very bitter." May 1943. *R. E. Schultes 5526.* — Río Macu-Paraná, lowland forest. "Root scrapings are used in preparing arrow poison mixture by Bara-Makú. *Awa-puh* (species of monkey root)." June 1–8, 1970. *P. Silverwood-Cope 23.*

Curarea tecunarum is well recognized as one of the principal sources of an especially strong curare in the northwestern Amazon. Its use as a contraceptive, however, is not widely known. According to *Prance, Maas, Woolcott et al. 16453,* the stem is crushed and placed in water, stirred and taken as a contraceptive by the Deni Indians of Brazil who call the plant *bekú.*

Telitoxicum peruvianum *Moldenke* in Brittonia 3 (1938) 45.

COLOMBIA: Comisaría del Vaupés, Río Piraparaná, Caño Teemeeña (Lobo Igarapé). "Small tree. Fruit dark green. Barasana: *bo-de '-mee-see.*" September 10, 1952. *R. E. Schultes et I. Cabrera 18340.*

The Makuna Indians valued *Telitoxicum peruvianum* as an important ingredient of the curare that formerly was prepared by medicine men of this tribe. The Barasana believe that application of crushed leaves to ulcers and similar infections aids in cleansing the wounds and hastens healing.

ANNONACEAE

Anaxagorea sp.

ECUADOR: Napo, Río Aguarico, Dureno. "Tree." December 12, 1965. *H. V. Pinkley 16.* — Same locality. "Small tree, 6–8 feet." October 19, 1966. *Pinkley 522.*

The bark of the root of this treelet is an ingredient of curare amongst the Kofáns. The Kofán name is *ko-yo-vi-fa-nti.*

Cyanogenesis is reported from a Philippine species of *Anaxagorea* (Hegnauer: loc. cit. 3 (1964) 121).

Guatteria Duckeana *R. E. Fries* in Acta Horti Berg. 12 (1939) 468.

COLOMBIA: Comisaría del Vaupés, Río Vaupés, Cachivera de Tatú. "Tree 45 feet. Flowers green." October 10, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24377.*

All parts of this plant tested very positive for alkaloids with Dragendorff reagent.

Guatteria dura *R. E. Fries* in Acta Horti Berg. 12 (1939) 499.

COLOMBIA: Comisaría del Vaupés, Río Kuduyarí. "Tree 18 feet. Flowers yellow-green, cauliforous." October 10, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24391.*

The Kubeos formerly employed this plant in a formula for making curare.

With Dragendorff reagent, the bark tested highly positive for alkaloids, the leaves slightly positive.

Several alkaloids have been reported from the genus *Guatteria* (Raffauf: loc. cit. (1970)).

Unonopsis veneficiorum *(Mart.) R. E. Fries* in Acta Hort. Berg. 12 (1939) 238.

COLOMBIA: Comisaría del Vaupés, Río Piraparaná. Right tributary of Río Macú-paraná. June 1–8, 1970. *P. Silverwood-Cope 11.* — Río Apaporis basin, Río Pacoa. February 7–12, 1952. *R. E. Schultes et I. Cabrera 15269.*

The nomadic Makú Indians of the Río Piraparaná have an extensive ethnopharmacopoeia. They indicate that *Unonopsis veneficiorum* is employed as an antifertility agent. Its name in Makú — *we-wit-kat-ku'* — means "no children medicine." No further information, unfortunately, is available concerning method of preparation and use.

The Barasana Indians of the Apaporis basin employ the root and bark of the lower stem in the preparation of an arrow poison. This report (Schultes: *Bot. Mus. Leafl., Harvard Univ.* 25 (1977) 114) represents apparently the third concerning the role of the plant in curare. The Puinaves, a number of whom migrated into the Río Apaporis area, were not aware of this use of *Unonopsis veneficiorum,* even though they know the plant and look upon it as "dangerous"; the Puinave name is *choon.*

This annonaceous species apparently is rather widely utilized in the Colombian Amazon as the basis of a curare. The first report was published by von Martius (Spix, J. B. et K. F. D. Martius: *Reise in Brasilien* (1831) 1237) who stated that Indians

in the Japurá or Caquetá valued it for this purpose. The second report (in Schultes, R. E.: *Bot. Mus. Leafl., Harvard Univ.* 22 (1969) 134–136) placed its use amongst the Kofán Indians along the border between Colombia and Ecuador on the basis of the collection *Pinkley 558*.

It is suspected that *Unonopsis veneficiorum* contains bis-benzylisoquinoline alkaloids (Hegnauer: loc. cit. 3 (1964) 118).

Xylopia amazonica *R. E. Fries* in Acta Horti Berg. 12 (1939) 562.

COLOMBIA: Comisaría del Amazonas, Río Apaporis, Soratama. "Large tree. Flowers white. High land." September 28, 1951. *R. E. Schultes et I. Cabrera 14146*.

Xylopia amazonica is valued by the Indians of the Río Apaporis in the form of a tea to induce sleep. The leaves and stems are employed.

Alkaloids, polyphenols and essential oils have been reported from *Xylopis* (Hegnauer: loc. cit. 3 (1964) 118, 120; Raffauf: loc. cit. (1970)).

Xylopia aromatica *(Lam.) Martius,* Fl. Bras. 13, pt. 1 (1841) 43.

COLOMBIA: Comisaría del Amazonas, Río Igaraparaná, La Chorrera. June 4–10, 1942. *R. E. Schultes 3951*. Comisaría del Vaupés, Río Vaupés, Urania. "Fruit red-purple. Small tree." September 27–October 20, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24393*.

This plant is strongly positive with a Dragendorff alkaloid test *(Schultes, Raffauf et Soejarto 24393)*.

Amongst the Witotos of the Río Igaraparaná, *Xylopia aromatica* is valued in the form of a weak tea as a strong diuretic used in cases of swellings of the legs. It must, according to the Indians, be administered with great caution.

Xylopia Benthamii *R. E. Fries* in Kgl. Sv. Vet.-Akad. Handl. 34, No. 5 (1900) 35.

COLOMBIA: Comisaría del Vaupés, Río Kananarí, Cerro Isibukuri. Alt. 2500 feet. "Small tree. Pods white and red. Forest on slope near summit." December 4, 1951. *R. E. Schultes et I. Cabrera 14751*.

According to the Taiwanos of the Río Kananarí, a tea of this plant is administered as a tranquilizer to people who have experienced a great fright.

The similarity in uses of *Xylopia amazonica* and *X. Benthamii* — to induce sleep and as a tranquilizer, respectively — suggests the advisability of chemical and pharmacological research.

Myristicaceae

Osteophloem platyspermum *(Poepp.) Warburg* in Nova Acta Acad. C. L. C. G. Nat. Cur. 68 (1897) 162.

Brazil: Estado do Amazonas, basin of Río Negro, Río Uneiuxi Makú Indian village 300 km. above mouth. "Forest on terra firme. Tree, 25 m × 40 cm diameter. Flowers green. Sap drunk by Makú as cure for coughs and colds. Makú = *tugnebãnpe.*" October 23, 1971. *G. T. Prance, P. J. M. Maas, D. B. Woolcott, O. P. Monteiro et J. F. Ramos 15571.* — Río Negro, vicinity of Manáos, Reserva Ducke. April 11–14, 1972. *R. E. Schultes et W. Rodrigues 26126a.*

The Makú drink the sap as a "cure for coughs and colds." Labourers in the Reserva Ducke near Manáos burn the leaves and inhale the smoke to relieve asthmatic conditions.

Chemical studies of *Osteophloem* apparently have not been effected.

Chrysobalanaceae

Licania apetala *(E. Mey) Fritsch* in Ann. K. K. Naturh. Hofmus. Wien 4 (1889) 54.

Colombia: Comisaría del Vaupés, Río Kananarí, Cerro Isibukuri. "Tree. Diameter 15 inches, height 75 feet." March 8, 1951. *R. E. Schultes et I. Cabrera 13276.*

The bark of this tree is burned, and the ashes are mixed with clay for making pots. The tree is known locally in Spanish as *cabio.* Its Indian names are: Kabuyarí — *ka'-ve;* Kuripako — *ka'-be;* Taiwano — *hna-mwa;* Puinave — *wan-choo'.*

Leguminosae

Acosmium nitens *(Vog.) Yakovlev* in Notes Roy. Bot. Gard. Edinb. 29 (1969) 353.

Brazil: Estado do Amazonas, Rio Negro, Tapurucuara. "Flowers white. Small tree. Bark very alkaloid-positive; petiole and leaf negative." July 5-August 12, 1967. *R. E. Schultes 24550* (Alpha Helix Amazon Expedition 1967).

The bark of this tree was indicated as an ingredient of curare made in former times by the Tukano Indians.

Nothing is known of the chemistry of this genus.

Brownea Ariza *Bentham,* Pl. Hartw. (1845) 171.

COLOMBIA: Comisaría del Putumayo, Buena Vista. "Flower bright red. Tree 10–12 feet tall. *Palo cruz."* September 13, 1972. *F. Piaguaje 11.*

According to the anthropologist Dr. Jean Langdon, the flower is prepared in a tea and used as a "vomitivo" to cure bleeding and excessive menstruation.

Campsiandra angustifolia *Spruce ex Bentham* in Martius, Fl. Bras. 15, pt. 2 (1870) 55.

COLOMBIA: Comisaría del Vaupés, Río Vaupés, Mitú and vicinity. "Flowers bright red, fragrant. Bush 9-10 feet." September 27–October 30, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24297.*
PERU: Departamento de Loreto, Iquitos region, San Antonio, Río Itaya. "*Huacapurana.* Large tree, 30 m in wet forest." July 30, 1966. *R. T. Martin et C. A. Lau-Cam 1189.*

The leaves of this plant are alkaloid negative with Dragendorff reagent.

According to the collectors of *Martin et Lau-Cam 1189,* in the Iquitos region an infusion or alcohol extract is taken twice a day for malaria.

No chemical studies of this genus have been reported.

Campsiandra laurifolia *Bentham ex Hooker,* Journ. Bot. 2 (1840) 94.

PERU: Departamento de Loreto, Provincia Maynas, Río Ampiyacu, Pebas and vicinity. "Forest near Pebas. Tree 10 m tall. Buds green. *Haucapurana."* April 23, 1977. *T. Plowman, R. E. Schultes et O. Tovar 6990* (Alpha Helix Amazon Expedition 1976–1977, Phase VII).

The bark of this small tree is employed in infusion by the Witoto Indians to treat wounds.

Cassia fruticosa *Miller* var. **Benthamiana** *(Harms) Macbride* in Field Mus. Publ. Bot. 13, pt. 3 (1943) 165.

ECUADOR: Napo, Río Aguarico, Dureno. "Small tree 25 m; flowers pale yellow; leaflet pairs fold in evening. Kofán: *kongi-hi."* May 22, 1966. *H. V. Pinkley 177.*

The bark of the twigs is prepared in a hot tea which is valued in treating earache.

Several alkaloids have been reported from *Cassia* (Raffauf: loc. cit. (1970)), and cyanogenic glycosides have been indicated from several species (Gibbs: loc. cit. 3 (1975) 1630).

Cassia macrophylla *Kunth,* Mimos. (1819) 126, t. 38.

ECUADOR: Napo, Río Aguarico, Dureno. "Kofán: *kongihiteta."* February 23, 1966. *H. V. Pinkley 154.*

According to the collector, the Kofán Indians use a wash prepared from this plant for earache and headache.

Cassia Ruiziana *Vogel,* Syn. Cass. (1837) 40.

ECUADOR: Napo, Río Aguarico, Dureno. "Kofán: *kongihisehépa." June 23, 1966. H. V. Pinkley 341.*

The bark of the branches is scraped into hot water to prepare a wash which the Kofáns use in treating earache, according to the collector.

Crudia amazonica *Spruce ex Bentham* in Martius, Fl. Bras. 15, pt. 2 (1870) 238.

COLOMBIA: Comisaría del Vaupés, Río Vaupés, Mitú and vicinity. September 27–October 20, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24192.*

The bark of this small tree is boiled to prepare a tea taken for emesis following food poisoning. The plant is alkaloid-negative.

The genus *Crudia* is chemically unknown.

Diplotropis Martiusii *Bentham* in Ann. Wien. Mus. 2 (1838) 88.

COLOMBIA: Comisaría del Vaupés, Río vaupés, Mitú and vicinity, Cachivera de Tatú. September 27–October 30, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24389.*

Among the Kubeo Indians, who call this plant *ko-ma ′-ma,* the leaves were formerly burned to make an ash mixed with powdered leaves of coca *(Erythroxylon Coca* Lam. var *Ipadu* Plowman). They also mix the dried leaves powdered with *fariña* to ingest when there is blood in the stool. The leaves are alkaloid negative with a Dragendorff spot test.

Heterostemon mimosoides *Desfontaines* in Mem. Mus. Paris 4 (1818) 248.

COLOMBIA: Comisaría del Vaupés, Río Vaupés, Mitú and vicinity. "Small tree or bush. Flowers purple. Alkaloid-negative." September 27–October 20, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24171.*

The flowers are said formerly to have been pulverized and used for flavoring *chicha*. The bark of this tree is alkaloid-negative with Dragendorff reagent.

Nothing is known of the chemical composition of *Heterostemon.*

Inga stenoptera *Bentham* in Hooker, Journ. Bot. 2 (1840) 143.

COLOMBIA: Comisaría del Vaupés, Río Vaupés, Mitú and vicinity. "Flowers white. Common bush along water's edge." September 27–October 30, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24256.*

The Kubeos call this plant *to-to ′-ko.* The leaves and bark are alkaloid-negative with Dragendorff reagent.

Macrolabium acaciaefolium *(Benth.) Bentham* in Martius, Fl. Bras. 15, pt. 2 (1870) 224.

COLOMBIA: Comisaría del Amazonas, Río Amazonas, near mouth of Río Loretoyacu and Puerto Nariño. "Tree 60 feet. Fruit round, green." September 13–15, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24142.*

The powdered leaves are used medicinally amongst the Tikunas to sprinkle on ulcerated wounds. The tree is know as *ma-ta ′-ke.*

Chemical studies of *Macrolabium* have apparently not yet been made.

Macrolabium multijugum *(DC.) Bentham* in Martius, Fl. Bras. 15, pt. 2 (1870) 222.

COLOMBIA: Comisaría del Vaupés, Río Vaupés, Mitú and vicinity. September 27–October 20, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24183.*

This spreading tree with brownish red flowers is alkaloid-negative. Some of the Indians living near Mitú state, however, that the fruits are poisonous.

Pterocarpus Rohrii *Vahl,* Symb. Bot. 2 (1791) 79.

COLOMBIA: Comisaría del Amazonas, Río Amazonas, near mouth of Río Loretoyacú and Puerto Nariño. September 13–15, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24163.*

The leaves of *Pterocarpus Rohrii* are held to be one of the most effective febrifuges of the area. They are taken in decoction.

Pterocarpus has not yet chemically been investigated.

Swartzia longistipitata *Ducke* in Bol. Técn. Inst. Agron. Norte, no. 2 (1944) 22.

BRAZIL: Estado do Amazonas, Rio Negro, vicinity of Manáos, grounds of I.N.P.A. "Fruit tan." April 11–14, 1972. *R. E. Schultes et W. Rodrigues 26104A.*

The people living in the country around Manáos are accustomed to use an infusion of the leaves as an anti-amenorrheal bath. The plant is known in Portuguese as *coquida.*

For a review of the limited amount of chemical information on *Swartzia,* see Schultes: *Journ. Ethnopharm.* 1 (1979) 79 ff.

Swartzia recurva *Poeppig et Endlicher,* Nov. Gen. et Sp. 3 (1845) 61.

BRAZIL: Estado do Amazonas, Rio Negro, vicinity of Manáos, km 45 Manáos-Caracarí, Reserva Biologica INPA. "Small tree. Fruit tree." April 11–14, 1972. *R. E. Schultes et W. Rodrigues 26173A.*

Country folk in the outskirts of Manáos believe that the fruits of this species are helpful in combatting physical debilitation due to age, malaria or other conditions. The pods are boiled and softened and added to regular food.

Swartzia sericea *Vogel* in Linnaea 11 (1837) 176.

BRAZIL: Estado do Amazonas, Rio Negro, vicinity of Manáos, Cachoeira Baixa de Tarumão. April 11–14, 1972. *R. E. Schultes et W. Rodrigues 26146A.*

The leaves of this species are considered to be toxic and were formerly employed in fishing in the outskirts of Manáos. It may be significant that the Kuripako Indians of the Río Guainía of Colombia report also that the leaves and bark were formerly used as a fish poison (Schultes: loc. cit. 86).

Tachigalia cavipes *(Spr. ex Bth.) Macbride* in Field Mus. Publ. Bot. 13, pt. 3 (1943) 127.

COLOMBIA: Comisaría del Vaupés, Río Apaporis, Jerijerimo. July 8, 1951. *R. E. Schultes et I. Cabrera 12981.* — Río Kananarí. September 29, 1951. *Schultes et Cabrera 14690.* — Río Vaupés, Mitú and vicinity. *H. Garcia-Barriga, R. E. Schultes et H. Blohm 16061.* Comisaría del Amazonas, Río Miritiparaná. May 8, 1952. *Schultes et Cabrera 16463.* Comisaría del Vaupés, Río Apaporis, Raud al Yayacopi. August 18, 1952. *Schultes et Cabrera 16963.* — Río Apaporis, Jinogojé. August 22, 1952. *Schultes et Cabrera 26997.* — Río Piraparaná, middle course. October 1, 1952. *Schultes et Cabrera 17137.* — Río Vaupés, near Mitú. November 13, 1952. *Schultes et Cabrera 18409.* — Río Piraparaná. June 1–8, 1970. *P. Silverwood-Cope sine num.*

The Bara Makú Indians of the Río Piraparaná, a poorly known nomadic group with an extensive knowledge of plant medicines, call this plant *wewitkatkú* ("no children medicine") and use it as an antifertility agent. There is no indication of how the plant is employed.

The anthropologist, Silverwood-Cope, collected with the same native name and the same antifertility use two different plants: *Unonopsis veneficiorum* (see above) and *Tachigalia cavipes.* It is possible that the Bara-Makú do have the same name for these two plants if the two are similarly used; it may also be possible that these Indians employ the two plants together for antifertility purposes.

Various tribes in the vicinity of Mitú use the powdered bark to "dry up" cankers of the mucous membrane of the mouth caused presumably by excessive use of coca. The Yukunas of the Río Miritiparaná value a tea of the leaves rubbed vigourously on swollen joints (arthritis?) as an anti-inflammatory.

This well known plant is called *hoo-be´-geen* ("flower of fierce ants") by the Makunas; *muin, muin-wan -shee´-pe-no* by the Puinaves; *ka-roo´-wo* by the Yukunas; and *wa-we -ra* by the Barasanas.

There is no chemical information on constituents of this interesting genus.

Tachigalia myrmecophila *(Ducke) Ducke* in Arch. Jard. Bot. Rio Jan. 3 (1922) 91.

COLOMBIA: Comisaría del Vaupés, Río Negro at confluence of Ríos Guainía and Casiquiare, Caño Ducuruapo. "Large tree along river bank. Flowers yellow." December 13–17, 1947. *R. E. Schultes et F. López 9389.*

The powdered bark is considered by the Kuripako Indians to be antiseptic for ulcerated sores. An infusion of the leaves is rubbed on painful limbs and causes a warmth which is said to relieve aches.

Tachigalia paniculata *Aublet,* Hist. Pl. Guian. Franç. 1 (1775) 372, t. 143, f. 1.

COLOMBIA: Comisaría del Amazonas, Río Loretoyacu. September 1946. *R. E. Schultes 8266.* Comisaría del Vaupés, Río Apaporis, Jinogojé. July, 1952. *R. E. Schultes et I. Cabrera 1979b.*

Amongst the Makunas of the Río Apaporis, the leaves of *Tachigalia paniculata* are boiled, and the hot infusion is rubbed on aching limbs.

Tachigalia ptychophysca *Spruce ex Bentham* in Martius, Fl. Bras. 15, pt. 2 (1870) 229.

COLOMBIA: Comisaría del Vaupés, Río Apaporis, Jerijerimo. "Tree 12 m high. Petals yellow, stamens white." July 7, 1951. *R. E. Schultes et I. Cabrera 12955.*

The Taiwano Indians of the Río Kananarí value an infusion of the leaves to alleviate chest pains when it is rubbed vigourously over the ribs.

Zornia leptophylla *(Benth.) Pittier* in Bol. Soc. Venez. Cienc. Nat. 6 (1940) 192.

COLOMBIA: Comisaría del Vaupés, Río Vaupés, Mitú and vicinity. "Small herb. Flowers yellow. Common. Open patch." September 27–October 20, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24408.*

The leaves and stems dried and pulverized are employed in the Mitú area as an insect repellent. The plant is alkaloid-negative.

OXALIDACEAE

Oxalis lotoides *Humboldt, Bonpland et Kunth,* Nov. Gen. et Sp. 5 (1821) 187.

COLOMBIA: Comisaría del Putumayo, Valle de Sibundoy. Alt. 2225-2300 m. May 29. 1946. *R. E. Schultes et M. Villarreal 7607.*

The Kamsá Indians prepare a decoction of this plant which is taken as a gargle to relieve chest and throat pains.

It is perhaps significant that the leaves of another species of this genus, the Amazonian *Oxalis Martiana* Zucc., are used in Brazil in the form of a gargle to relieve pains of angina (LeCointe: *A Amazonia Brasileira* 3 (1934) 108).

Leucoanthocyanines have been reported from some species of *Oxalis* (Bate-Smith, E. C.: *Journ. Linn. Soc. London (Botany)* 58 (1962) 95–173).

Polygalaceae

Polygala sp.

Ecuador: Napo, Río Aguarico, Dureno. 1966. *H. V. Pinkley 226.*

A cold-water infusion is drunk for "pains around the heart" by the Kofán Indians of the Río Aguarico in Ecuador. The plant is known by these natives as *ka-ta-pa-si-vi-sehe ′-pa.*

Vochysiaceae

Qualea acuminata *Spruce ex Warming* in Martius, Fl. Bras. 13, pt. 2 (1875) 40.

Colombia: Comisaría del Vaupés, Río Vaupés, Mitú and vicinity. "Small tree. Flowers white and pink." September 27–October 20, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24177.*

This plant tests alkaloid-negative with Dragendorff reagent. A tea of the bark is valued as a taenifuge in the Mitú area.

The literature has no report on the organic constituents of *Qualea.*

Euphorbiaceae

Croton glabellus *Linnaeus*, Syst. Ed. 10 (1759) 1275.

Colombia: Comisaría del Amazonas, near mouth of Río Loretoyacú and Puerto Nariño. "Fruit green. Small tree." September 13–15, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24149.*

Witoto Indians living in the vicinity of Leticia crush leaves of this tree to poultice infected cuts and sores.

Croton glabellus has been reported to be alkaloid-positive (Haynes, L. J. et K. L. Stuart: *Journ. Chem. Soc.* 1963 (1963) 1784, 1789). The genus appears to be relatively well furnished with alkaloids (Raffauf: loc. cit. (1970); Gibbs: loc. cit. 3 (1974) 1353, 1359).

Croton palanostigma *Klotsch* in Hooker Lond. Journ. Bot. 2 (1843) 48.

BRAZIL: Estado do Amazonas, Rio Negro, vicinity of Manaos, Reserva Ducke. "Small tree. Flowers white." April 11–14, 1972. *R. E. Schultes et W. Rodrigues 26124a.*

The sap of this tree is applied to ulcers and boils to reduce pain.

Euphorbia sp.

Amongst the Kofáns, the latex of this *Euphorbia* is put into infected cracks in the skin on the bottom of the feet—an infection caused probably by fungal organisms. The Kofán name is *shi-vak-o-sehe´-pa (H. V. Pinkley 42,* cited in Pinkley: *The Ethnobotany of the Kofán Indians.* Unpublished Ph.D. thesis, Harvard University (1973) 217).

Mabea nitida *Spruce ex Bentham* in Hooker, Kew Journ. 6 (1854) 367.

COLOMBIA: Comisaría del Vaupés, Río Vaupés, Mitú and vicinity. "Tree 20 feet. Fruit rusty. Alkaloid: negative." September 27–October 20, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24170.*

According to Kubeo informants, the oil extracted from the seeds was in former times rubbed into the scalp to prevent or delay loss of hair.

The genus *Mabea* has not been chemically investigated.

SAPINDACEAE

Paullinia Yoco *R. E. Schultes et Killip ex Schultes* in Bot. Mus. Leafl., Harvard Univ. 10 (1942) 302.

COLOMBIA: Comisaría del Putumayo, Río Putumayo, Remanso. August 22, 1966. *H. V. Pinkley 380.*
ECUADOR: Napo, Río Aguarico, Dureno. January 3, 1966. *Pinkley 72.* — Río Aguarico, Pisorini, June 22, 1966. *Pinkley 311.* — Same locality and date. *Pinkley 312.* — Río Aguarico, Dureno. September 6, 1966. *Pinkley 428.*

Employed widely in the Colombian Putumayo and adjacent Ecuador as a caffeine-rich stimulant, yoco apparently is represented by several ecotypes, recognized by the natives and given names but to the botanist seemingly indistiguishable. More field work and more meticulous studies of the liana are required before a complete understanding of the variants known in the native pharmacopoeas is available.

According to the collections cited above, the Kofán Indians recognize two ecotypes under the names *to-to-oa-yoko* ("white yoco") and *cu-i-yoko. Pinkley 380* indicates that *totoayoko* "has more *leche* [latex] than other types of yoko, therefore is the best type."

Serjania sp.

Crushed leaves of this *Serjania* are dried and applied to sores of the mouth by the Kofáns of Ecuador. The Kofán name of this medicinal plant is *si-si-pak-opifa-sehe'-pa (H. V. Pinkley 220* and *420,* cited in Pinkley: loc. cit.).

Saponins and pyrrolizidine alkaloids have been reported from the genus *Serjania* (Gibbs: loc. cit. 3 (1974) 1708, 1710).

Balsaminaceae

Impatiens sp.

An infusion of the flowers is taken internally for sore throat by the Kofáns of Ecuador *(H. V. Pinkley 447* and *1973,* cited in Pinkley: loc. cit.) The Kofán name is *carakuchu-sehe'-pa.*

Polyphenols and naphthoquinone are reported from the genus *Impatiens* (Hegnauer: loc. cit. 3 (1964) 229–231).

Sterculiaceae

Herrania Camargoana *R. E. Schultes* in Bot. Mus. Leafl., Harvard Univ. 14 (1950) 120.

Brazil: Estado do Amazonas, Rio Cauaburí, Maturacá. "Single slender trunk. Height 20 ft. In flood forest. Fruit brownish red with fleshy pseudospines at junction of ribs and cross ridges. Alkaloid negative." July 5 August 12, 1967. *R. E. Schultes 24572* (Alpha Helix Amazon Expedition, 1967).

The bitter seeds of *Herrania Camargoana* are pulverized and employed as a condiment on game-meat by the Waika Indians of the Rio Cauaburí in northwestern Brazil.

Herrania Mariae *(Mart.) Decaisne ex Goudot* in Ann. Sci. Nat. 3, 2 (1844) 233.

PERU: Departamento Loreto, Provincia Maynas, Rio Ampiyacu, Puca Urquillo and vicinity. "Unbranched tree 5 m tall in open thicket. Flowers cauliflorous. Sepals purplish brown. Petals cream with red nerves. Staminodes foliose, red-purple." April 2, 1977. *T. Plowman, R. E. Schultes et O. Tovar 6565* (Alpha Helix Amazon Expedition 1976–77 Phase VII).

Although this species is to be expected in the area, it apparently represents only the second collection from Peru. The other collection was made in the Madre de Dios.

BOMBACACEAE

Bombax globosum *Aublet,* Hist. Pl. Guian. Franç., 2 (1775) 701, t. 281.

COLOMBIA: Comisaría del Vaupés, Río Kananarí, Cerro Isibukuri. "Large tree, 60–70 feet tall. Flowers yellow-white, petals yellow towards tip." September 29, 1951. *R. E. Schultes et I. Cabrera 14700.*

The Taiwano Indians, who know this tree as *ka-ne-wee ′-re,* gathered the "wool" from the ripened fruits for use, mixed with latex or resin from a number of plants, to apply to cuts, open sores or ulcers as a kind of protection during healing.

MARCGRAVIACEAE

Souroubea guianensis *Aublet* var. **corallina** *(Mart.) Wittmack* in Martius, Fl. Bras. 12, pt. 1 (1878) 252.

COLOMBIA: Comisaría del Amazonas, Río Apaporis, vicinity of Cachivera de Jerijerimo. September 16, 1951. *R. E. Schultes et I. Cabrera 14076.*

The Taiwano Indians living along the Río Kananarí indicate that a decoction of this plant is administered over a period of a week or ten days to aged members of the tribe who suffer from "susto" (i.e., a psychological condition of fear or apprehension resulting often from the belief that hexing by an enemy has been successful).

Little is known of the chemistry of the Marcgraviaceae. Tannins and leucoanthocyanins have been reported from some species of *Marcgravia* (Gibbs: loc. cit. 3 (1974) 1371).

Souroubea guianensis *Aublet* var. **cylindrica** *Wittmack* in Martius, Fl. Bras. 12, pt. 1 (1878) 253.

COLOMBIA: Comisaría del Vaupés, Río Vaupés, Circasia. Sandy savannah, quartzite base. Alt. about 800 feet. "Fruit brown." April 20, 1953. *R. E. Schultes et I. Cabrera 19214.* — Same locality. "Flowers orange-red." November 1953. *R. E. Schultes et I. Cabrera 19697.*

The Karijona Indians residing in the upper Río Vaupés value a tea of the leaves of this plant as a tranquilizing medicine.

Souroubea pachyphylla *Gilg* in Engler, Bot. Jahrb. 25 Beibl. 60 (1898) 33.

COLOMBIA: Comisaría del Amazonas, Río Amazonas, Leticia. January 28–February 7, 1969. *T. Plowman, T. Lockwood, H. Kennedy et R. E. Schultes 2318.*

From the dried leaves, the Witoto Indians living near Leticia (who originally came from the Río Igaraparaná) prepare a pomade with animal fat for application to the eyes in cases of extreme infection from conjunctivitis.

GUTTIFERAE

Caraipa parvielliptica *Cuatrecasas* in Rev. Acad. Col. Cienc. 8, No. 29 (1950) 64.

COLOMBIA: Comisaría del Vaupés, Río Kananarí, Cerro Isibukuri. "Bush along rill." April 12, 1951. *R. E. Schultes et I. Cabrera 14738.* Comisaría del Amazonas, Río Apaporis, Soratama. "Height 60 feet." March 26, 1952. *R. E. Schultes et I. Cabrera 16070.* — Río Miritiparaná. "Small tree. Yukuna: *see - na.*" May 8, 1952. *R. E. Schultes et I. Cabrera 16460.*

The Yukunas apply the sap of *Caraipa parvielliptica* to sores of the mucous membrane of the mouth. In Brazil, the sap of *C. paraensis* Huber and *C. grandifolia* Martius is similarly employed for herpes, mange and itches (Le Cointe: *A Amazonia Brasileira* 3 (1934) 424).

Several species of *Caraipa* have been reported to contain a high content of resins which are useful in treating a variety of skin

diseases. A highly toxic vermifugal constituent has been found in the seeds of *Caraipa* (Freise, F. W.: *Apoth. Zeit.* 44 (1929) 1481). Xanthones are abundant in the family (Gibbs: loc. cit. 3 (1974) 1388).

Symphonia globulifera *Linnaeus filius,* Suppl. (1781) 302.

COLOMBIA: Comisaría del Amazonas, Río Apaporis, Soratama. "Flowers red. Height 75 feet." December 14, 1951. *R. E. Schultes et I. Cabrera 14904.*

The bark of this tree, souce of a very useful resinous latex, is said by the Indians of the middle Río Apaporis to be very effective, when burned to ashes and applied to recalcitrant ulcers of the abdomen and legs, in rapidly drying the infection.

Vismia ferruginea *Humboldt, Bonpland et Kunth,* Nov. Gen. et Sp. 5 (1821) 141.

BRAZIL: Estado do Amazonas, Manáos, Flores. "Flowers greenish white. Common bush in scrub growth." July 5–August 12, 1967. *R. E. Schultes 24594* (Alpha-Helix Amazon Expedition 1967).

The resinous exudate of this bush is commonly applied in the region of Manáos to sores of the skin .

An unidentified alkaloid has been reported from *Vismia robusta* (Willaman, J. J. and B. G. Schubert: *Alkaloid-bearing Plants and their Contained Alkaloids,* Techn. Bull. U.S.D.A. No. 1234 (1961) 91). Nothing else is known of the chemistry of *Vismia* which might explain the folk use in treating skin sores.

FLACOURTIACEAE

Banara guianensis *Aublet,* Hist. Pl. Guian. Franç., 2 (1775) 548.

COLOMBIA: Comisaría del Vaupés, Río Vaupés, Mitú and vicinity. "Bushy tree, common on river bank. Flowers green-yellow." September 27–October 20, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24176.*

A spot test with Dragendorff reagent gave a doubtful positive result for alkaloids.

Sundry species of *Ryania* are recognized in South America as poisonous. The toxicity is due presumably to a glycoside (Merz, K. W.: *Arch. Pharm.* 268 (1930) 592; Nakarai, S. et T. Sano: *Arch. Pharm.* 272 (1934) 1).

Mayna longifolia *Poeppig et Endlicher* Nov. Gen. et Sp. 3 (1845) 64.

COLOMBIA: Comisaría del Amazonas, Río Miritiparaná, Caño Guacayá. "Fruit cauline, greenish white." April 24, 1952. *R. E. Schultes et I. Cabrera 16285.*

The seeds of this shrub are crushed and boiled in water to make a tea to provoke vomiting in cases of serious food poisoning, especially from tainted fish. The tea must, however, be used with caution, since it is reputedly toxic, causing extreme dizziness, profuse sweating and uncontrollable trembling.

The plant is well known by all Indians of the area. The Makuna call it *oo-too-mee'-ko;* the Miraña, *do'-ro-he; ya-poo'-moo-ho;* the Yukuna, *ka-sa'-ra ("beetle tree").*

Mayna longifolia *Poeppig et Endlicher* var. **phasmatocarpa** *R. E. Schultes* in Bot. Mus. Leaf., Harvard Univ. 12 (1946) 125.

COLOMBIA: Comisaría del Vaupés, Río Vaupés near confluence of Ríos Unilla and Itilla. January 13, 1944. *R. E. Schultes 5728.*

This treelet is known in Spanish as *cacaoito* and *cacao blanco;* in Karijona, *ha-pe'-ta-ke.*

The orange-red aril of the seeds is applied to the gums to staunch bleeding.

Mayna toxica *R. E. Schultes* in Rhodora 65 (1963) 16, t. 10.

COLOMBIA: Comisaría del Amazonas, Río Caquetá, La Pedrera and vicinity, Quebrada Tonina. On high land. "Small tree, 20 feet tall. Flowers white." October 5, 1952. *R. E. Schultes et I. Cabrera 17731.*

The Miraña Indians of the La Pedrera region assert that formerly the bark or seeds of this tree were given to dogs as a poison. The same uses have hitherto been reported (Schultes: *Rhodora* 65 (1963) 16) from the Vaupés and for other Indian tribes. It was then indicated that: "The fact that at least two species—*Mayna muricida* and *M. toxica*—are similarly employed for their toxic properteries by Indians in far-separated parts of the Colombian Amazon suggests that an investigation into the chemical constituents of this genus might be of interest."

Mayna sp.

The Kofáns of Ecuador treat toothache by rinsing the mouth with an infusion made by boiling the bark of this small tree in water. The plant is called *tsahave-kwa-sehe'-pa* by these Indians *(H. V. Pinkley 567,* cited in Pinkley: loc. cit.).

Ryania angustifolia *(Turcz.) Monachino* in Lloydia 12 (1949) 21.

COLOMBIA: Comisaría del Vaupés, Río Vaupés, Mitú and vicinity. "Small tree in secondary growth. Flowers white. Leaves and twigs: alkaloid doubtful. Bark: alkaloid negative." September 27–October 20, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24175.*

The root is considered to be poisonous by the Kubeo Indians. It is dried, powdered and used to rid clothing and hammocks of lice.

One species, *Ryania dentata,* has been reported as an ingredient of an arrow poison in Colombia (Mezey, K.: *Rev. Acad. Col. Cienc. Exact. Fís. Nat.* 7 (1947) 319). Several species of *Ryania* have been reported to have insecticidal principles (Hegnauer: loc. cit. 4 (1966) 166).

BEGONIACEAE

Begonia sp.

An infusion of the crushed leaves is employed amongst the Kofán Indians of Ecuador as a wash for "sore eyes." In the Kofán language, the plant is called *avina-chu-sehe'-pa (H. V. Pinkley 17, 214* and *441,* cited in Pinkley: loc. cit.).

THYMELIACEAE

Schoenobiblus peruvianus *Standley* in Field Mus. Publ. Bot. 6 (1936) 169.

COLOMBIA: Comisaría del Putumayo, Río Guamués, Santa Rosa. September 6, 1966. *H. V. Pinkley 436.* Comisaría del Putumayo, Río San Miguel, Santa Rosa. November 30, 1966. *Pinkley 565.*

The names of this shrub amongst the Kofáns are *andeki* and *shi-ra-chu-se-he'-pa;* in Spanish, it is known as *kegar.*

The Kofáns employ the bark of the root and the fruit in making curare. The plant is likewise used as a fish poison.

Nothing is known of the chemistry of *Schoenobiblus.*

Lythraceae

Cuphea sp.

Known in Kofán as *sivi,* this small plant is burned, and the ashes are applied to treat sores of the mouth *(H. V. Pinkley 37,* cited in Pinkley: loc. cit.)

Lecythidaceae

Chytroma valida *Miers* in Trans. Linn. Soc. 30 (1874) 241.

Colombia: Comisaría del Vaupés, Río Vaupés, Cerro Mitú. "Flowers yellow-cream, fragrant." September 27 October 30, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24250.*

All parts of this plant are alkaloid-negative with Dragendorff reagent.

Combretaceae

Combretum Cacoucia *Exell* in Kew Bull. 1931 (1931) 469.

Brazil: Estado do Pará, Utinga, Belém. *"Rabo de arara.* Extensive liana. Acrid water in stem. Flowers red, said to be poisonous." September 1947. *R. E. Schultes 8668.*

Numerous reports, similar to the folk report from Belém do Pará connected with this collection, state that the flowers of *Combretum Cacoucia* are toxic. There is apparently no chemical evidence to sustain this assertion, yet the number of reports is such that the problem bears serious study.

Caffeine and tannins have been reported from the genus *Combretum* (Gibbs: loc. cit. 3 (1974) 1478).

Melastomaceae

Graffenrieda rupestris *Ducke* in Arch. Inst. Bio. Veg. Rio Janeiro 2 (1935) 66.

COLOMBIA: Comisaría del Vaupés, Río Vaupés, Mitú and vicinity, Cachivera de Tatú. "Tree 40 feet. Flowers white, fragrant." September 27–October 30, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24381.*

The natives rub the leaves of this tree on hands that have been blistered from excessive paddling. They are alkaloid-negative with a Dragendorff spot test.

This is the first reference to *Graffenrieda rupestris* in Colombian territory.

ERICACEAE

Gaultheria anastomosana *Humboldt, Bonpland et Kunth,* Nov. Gen. et Sp. 3 (1819) 285.

COLOMBIA: Departamento de Cundinamarca. Pantano Redondo, Zipaquirá, 3200–3250 m. July 13, 1960. *R. E. Schultes 22467.*

Farmers near Zipaquirá assert that this low shrub poisons cattle and sheep.

Glycosides are known from several species of *Gaultheria* (Hegnauer: loc. cit. 4 (1966) 75).

MYRSINACEAE

Conomorpha obovata *Mez* in Bull. Herb. Boiss. ser. 2, 5 (1905) 535.

COLOMBIA: Comisaría del Vaupés, right tributary of Rio Macu-paraná. Lowland forest. June 1–8, 1970. *P. Silverwood-Cope 3.*

The meaning of the name of this plant amongst the Bara-Makú of the Río Piraparaná of Colombia—*maw-ye -at-puh* "tooth bewitched root"—is probably indicative of the use of the root to allay toothache. Scrapings of the root are placed on the tooth.

Stylogyne amplifolia *Macbride* in Field Mus. Publ. Bot. 11 (1931) 33.

COLOMBIA: Comisaría del Amazonas, Río Putumayo, near mouth of Río Igaraparaná. June 1942. *R. E. Schultes 3989.*

The Witotos of the region of the Río Putumayo on the Colombo-Peruvian boundary refer to *Stylogyne amplifolia* as *jipina coca, coca silvestre, taife jipina, taife diablo* and *tayfe*

heepeena. These names all suggest that the plant may serve as a substitute for *Erythroxylon Coca* var. *Ipadu* or that it may be one of the additives used with coca leaves in the region.

Loganiaceae

Strychnos Erichsonii *R. Schomburgk* Fauna Fl. Brit. Guian. (1848) 1082; in Martius, Fl. Bras. 6, pt. 1 (1868) 274, t. 82, fig. 2.

Colombia: Comisaría del Vaupés, Río Vaupés, at mouth of Río Kubiyú. "Flowers white, fragrant. Fruit orange. Extensive vine." September 27–October 30, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24248.*

The Indians of the lower Río Vaupés formerly employed this species in preparing an arrow poison. With a Dragendorff test, the leaves were strongly positive, the bark doubtfully so.

Potaliaceae

Potalia Amara *Aublet,* Hist. Pl. Guian. Franç. 1 (1775) 394, t. 151.

Brazil: Estado do Amazonas, Rio Negro basin. Rio Uneiuxi. Makú Indian village 300 km above mouth. "Treelet, 3 m tall. Root bark scraped, mixed with Menispermaceae *15560* as ingredient for Makú snake-bite cure. *Awuibiden* (awa = "snake")." October 23, 1971. *G. T. Prance et al. 15559.*
Colombia: Comisaría del Vaupés, Río Vaupés, Cerro Mitú. "Flowers yellow. Used against snake bite. Five feet tall. *Martiguaje."* August 20, 1960. *R. E. Schultes 23708.*
Peru: Departamento Loreto, Provincia Mayna. Río Yaguasyacu, Brillo Nuevo. "Shrub 2 m in front; fresh leaves chopped with water taken internally for snake bite or against any poisonous animal (vaya, insulo). Calms the body and eliminates pain." April 12, 1977. *T. Plowman, R. E. Schultes et O. Tovar 6803* (Alpha Helix Amazon Expedition 1976–1977; Phase VII).

Potalia Amara, perhaps because of a "Doctrine of Signature" effect, is widely valued as a snake bite remedy in South America. The extent of this esteem is indicated by the reports connected with the material cited above—reports on four herbarium specimens from four different Amazonian countries. The use of this plant to combat snake bite could easily by greatly expanded by citing scores of reports in the literature.

Notwithstanding the important place held in folk medicine of tropical America by *Potalia Amara,* little is known of the active constituents of the plant.

Gentianaceae

Chelonanthus alatus *(Willd. ex Griseb.) Pulle,* Enum. Pl. Surinam. (1906) 376.

Colombia: Comisaría del Vaupés, Río Vaupés, Cerro de Mitú. "Height 5 feet. Flowers yellow-green." September 27–October 20, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24346.*

This species is alkaloid-negative with Dragendorff reagent.

The Kubeo Indians take a tea of the roots and leaves to relieve a stomach condition caused apparently by eating tainted meat or fish.

Apocynaceae

Aspidosperma Schultesii *Woodson* in Ann. Mo. Bot. Gard. 38 (1951) 168.

Colombia: Comisaría del Vaupés, Río Apaporis, Jinogojé (at mouth of Río Piraparaná) and vicinity. "Large tree." July 1952. *R. E. Schultes et I. Cabrera 19786.*

The latex of *Aspidosperma Schultesii* is valued amongst the Makuna and other Indians of the middle course of the Río Apaporis and the Río Piraparaná in the treatment of infected sores (possibly of fungal origin) between the toes. It is spread over the raw flesh and dried, acting as a protection to the wound.

A summary of the known chemical constitution of the genus *Aspidosperma* may be found in Schultes: *Journ. Ethnopharm.* 1 (1979) 167.

Tabernaemontana stenoloba *Mueller-Argoviensis* in Linnaea 30 (1859–60) 407.

Colombia: Comisaría del Amazonas, Río Caquetá, La Pedrera. October 3, 1952. *R. E. Schultes et I. Cabrera 17690.*

Natives in the region of La Pedrera maintain that latex in the leaves of this plant is toxic to the skin.

For a brief summary of the organic constituents in *Tabernaemontana,* see Schultes: loc. cit. 1 (1979) 184.

Boraginaceae

Cordia sp.

Amongst the Ecuadorian Kofáns, who call the plant *kai-ya-hi-cho-sehe´-pa,* a cold-water infusion of the bark is valued as a cough medicine *(H. V. Pinkley 39,* cited in Pinkley: loc. cit.).

Saponines, tannins, alkaloids and cyanogenesis have been reported from several species of *Cordia* (Gibbs: loc. cit. 3 (1974) 1749–1751).

Verbenaceae

Lantana sp.

A decoction, made by boiling the leaves in water, is valued by the Kofáns of Ecuador as a febrifuge; it is also taken as an emetic. The native name of the plant is *anono-sehe´-pa (H. V. Pinkley 167,* cited in Pinkley: loc. cit.).

An alkaloid has been reported from *Lantana* (Raffauf: loc. cit. (1970)). Saponines, tannins and cyanogenesis have likewise been indicated for the genus (Gibbs: loc. cit. 3 (1974) 1752).

Stachytarpheta sp.

Undoubtedly a recent introduction to the Kofán region, this *Stachytarpheta,* known only by its Spanish name *verbena,* is prepared in decoction and is drunk to relieve stomach pains *(H. V. Pinkley 292,* cited in Pinkley: loc. cit.).

Saponines and cyanogenesis are reported for *Stachytarpheta* (Gibbs: loc. cit. 3 (1974) 1752).

Solanaceae

Acnistus arborescens (L.) Schlechtendal in Linnaea 7 (1832) 67.

Colombia: Departamento del Huila, Pitalito, Quinche. 1300 m alt. December 30, 1942. *R. E. Schultes et M. Villarreal 5102.*

The berries of *Acnistus arborescens* are considered medicinal for treating colic by the peasants of southern Huila. They are prepared in the form of a tea.

An alkaloid — acnistine — has been reported for the genus (Raffauf: loc. cit. (1970)). *Acnistus arborescens,* the leaves of which have yielded withaferin A and withacnistin, has been used as an anti-cancer plant (Kupchan, M. *et al.: Journ. Am. Chem. Soc.* 87 (1965) 5805; *Journ. Org. Chem* 34 (1969) 3858). Studies have indicated that this widespread tropical American species has a number of chemical races, for other analyses of the same species have yielded other compounds (Barata, L. *et al.: Chem. Abstr.* 75 (1971) 115901).

Cestrum loretense *Francey* in Candollea 6 (1935) 225.

COLOMBIA: Comisaría del Amazonas, Trapécio Amazónico, Río Loretoyacu. "Bush. Flowers greenish yellow." September–November, 1944. *R. E. Schultes 6018.*

Amongst the Tikuna Indians, *Cestrum loretense* is reputedly toxic.

The alkaloids parquine and solasodine are reported from this genus (Raffauf: loc. cit. (1970)). Saponines and tannins have been reported from *Cestrum* (Gibbs: loc. cit. 3 (1974) 1764).

Cestrum ochraceum *Francey* in Candollea 6 (1935) 343.

COLOMBIA: Comisaría del Putumayo, Valley of Sibundoy. "Flowers blue-black." May 29, 1946. *R. E. Schultes et M. Villarreal 7658.* Same locality. "Tree 5 m tall. Strong narcotic odor. Corolla cream to purplish brown. Fruit bluish." November 11, 1968. *T. Plowman 2006.*

The Indian medicine men of Sibundoy value the bluish or purplish fruits of *Cestrum ochraceum* in the form of a tea to provoke intensive sweating in the treatment of rheumatic pains. The patient is said to suffer a slight delirium if too much of the preparation be taken.

Cestrum reflexum *Sendtner ex Martius* var. **densiflorum** *Francey* in Candollea 6 (1935) 267.

COLOMBIA: Comisaría del Amazonas, Río Putumayo, near mouth of Río Igaraparaná. June 18, 1942. *R. E. Schultes 3994.*

The Witoto Indians of the Río Igaraparaná consider the leaves and roots of this plant to be virulently toxic.

Cyphomandra endopogon *Bitter* in Engler, Bot. Jahrb. 54, Beibl. 119 (1916) 16.

COLOMBIA: Comisaría del Putumayo, Río Sucumbios, Quebrada Conejo. "Bush. Flowers green, anthers white. Fruits round, green, hard." April 2-5, 1942. *R. E. Schultes 3652.*

The leaves of *Cyphomandra endopogon* are used by the Kofán Indians to dye clay pots black.

Alkaloids have been reported from *Cyphomandra* (Raffauf: loc. cit. (1970)). Several carotinoids occur in the genus (Gibbs: loc. cit. 3 (1974) 1765.).

Datura suaveolens *Humboldt et Bonpland ex Willdenow*, Enum, Hort. Berol. (1809) 227.

According to Pinkley, the Kofańs give this plant to dogs for an unspecified reason. It is possible that they believe that this treatment may enhance the animal's prowess in the hunt. The Kofáns refer to the plant as *ain-vai (H. V. Pinkley 76, 506*, cited in Pinkley: loc. cit.).

This use may be related to the mydriatic properties of atropine.

Jaltomata procumbens *(Cav.) J. L. Gentry* in Phytolog. 27 (1973) 287.

COLOMBIA: Comisaría del Putumayo, Sibundoy. Alt. 2225-2300 m. May 29, 1946. *R. E. Schultes et M. Villarreal 7615.*

A tea of this plant is used in Sibundoy as a diuretic and febrifuge.

Nothing is known of the chemistry of this rare solanaceous species.

Juanulloa ochracea *Cuatrecasas* in Brittonia 10 (1958) 148.

COLOMBIA: Comisaría del Caquetá, Río Caquetá. Secondary forest near Floresta, c. 16 km downriver from Puerto Limón. "Climbing epiphytic shrub on fallen tree, 3 m tall. Calyx red, corollar yellow; leaves coriaceous. Trunk and leaves used for wounds. V. n. 'ayahuasca' (Inga)." December 20, 1968. *T. Plowman 2176.* Comisaría del Putumayo, Buena Vista. "Plant used to cure 'depo-wara'—when the heart palpitates. Stem grated and gratings mixed with water. *Siona-bi-tika-uko.* October 29, 1972. *L. Piagueje s. n.* (for J. Langdon).

The application to *Juanulloa ochracea* of the name *ayahuasca* may indicate that it represents either a species employed directly as the source of a narcotic or one of the numerous plant additives to the hallucinogenic drink made basically from the bark of *Banisteriopsis Caapi* or *B. inebrians* (Schultes: *Bot. Mus. Leafl., Harvard Univ.* 23 (1972) 140). There is chemical support for this belief. The alkaloid parquine has been reported from a species of *Juanulloa* (Raffauf: loc. cit. (1970)).

Markea coccinea *L. C. Richard* in Acta Soc. Hist. Nat. Paris 1 (1792) 107.

COLOMBIA: Comisaría del Vaupés, upper Río Vaupés, January 1944. *G. Gutiérrez et R. E. Schultes 575.* — Lago de Pasos, upper Río Vaupés. February 19, 1944. *Gutiérrez et Schultes 859.*

A medicine man of the nearly extinct Karijona tribe indicated that the leaves of this plant were frequently dried, powdered and eaten with *fariña,* the flour of *Manihot esculenta,* to expel intestinal parasites. The Karijona name of *Markea coccinea* is *e-ree'-ko-pa.*

The use of a decoction of the leaves of this species has been reported in the treatment of conjunctivitis and other eye diseases by the Desano Indians (Schultes: *Bot. Mus. Leafl., Harvard Unive.* 26 (1978) 192).

Nothing is known of the chemical constituents of *Markea.*

Saracha procumbens *(Cav.) Ruiz et Pavón,* Fl. Peruv. 2 (1799) 43.

COLOMBIA: Comisaría del Putumayo, Valle de Sibundoy, Sibundoy and vicinity. Alt. 2225–2300 m. May 29, 1946. *R. E. Schultes et M. Villarreal 7615.* — Same locality. August 22, 1963. *M. L. Bristol 1328.*

According to Bristol, the Kamsá Indian name of this garden plant, the fruit of which is edible, is *chuftanguemesha.* A tea of the whole plant is drunk as a diuretic and febrifuge *(Schultes et Villarreal 7615).*

Apparently no chemical studies on *Saracha* have been published.

Solanum apaporanum *R. E. Schultes* in Bot. Mus. Leafl., Harvard Univ. 13 (1949) 292.

COLOMBIA: Comisaría del Vaupés, Río Vaupés, Mitú and vicinity. "Vine. Flower white. Fruit orange." September 27–October 20, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24300.*

This vine is alkaloid-positive with Dragendorff reagent.

Solanum crinitipes *Dunal* in De Candolle, Prodr. 13, pt. 1 (1852) 317.

COLOMBIA: Departamento de Cundinamarca, between Agua Bonita and Aguadita. Alt. 2300 m. *H. García-Barriga et G. Stout 18886.*

The fruits of this species are reported to be toxic.

Solanum jamaicense *Miller,* Gard. Dict., Ed. 8 (1768) no. 17.

COLOMBIA: Comisaría del Amazonas, Trapécio Amazónico, Leticia. September, 1946. *R. E. Schultes 8207.* — Leticia and vicinity. August–September 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24098.*

A Dragendorff test of *Solanum jamaicense* is doubtfully alkaloidal. The Tikuna Indians of the region of Leticia employ a warm decoction of the leaves as a wash for the elimination of body parasites.

Solanum lepidotum *Humboldt et Kunth ex Dunal,* Solan. Syn. (1816) 17.

COLOMBIA: Comisaría del Putumayo, Valley of Sibundoy. May 29, 1946. *R. E. Schultes et M. Villarreal 7674.*

Solanum lepidotum serves the Indians of Sibundoy as an anti-rheumatic. Crushed leaves are vigourously rubbed on aching joints to provided temporary relief.

Solanum liximitante *R. E. Schultes* in Bot. Mus. Leafl., Harvard Univ. 19 (1962) 248.

COLOMBIA: Comisaría del Amazonas, Río Amazonas, Puerto Nariño. "Mature fruit eaten fresh; juice used to make refrescos." October 5, 1972. *L. L. Glenboski C-84.*

According to the collector, this shrubby species with edible fruits is called *coconilla* in the Trapécio Amazónico. This widely

cultivated plant is known by a number of indigenous names in the northwest Amazon (Schultes et Romero-Castañeda: *Bot. Mus. Leafl., Harvard Univ.* 19 (1962) 249–250).

Solanum mammosum *Linnaeus,* Sp. Pl. (1753) 187.

COLOMBIA: Comisaría del Putumayo, Río Putumayo, Puerto Ospina. "*Ku-ku-na; tetilla.* March 23–25, 1942. *R. E. Schultes 3450.* Comisaría del Amazonas, Río Karaparaná, between El Encanto and the mouth. May 22–28, 1942. *Schultes 3808.*

ECUADOR: Napo, Dureno, Río Aguarico. February 28, 1966. "Kofán = ko-ko -no-cho." *H. V. Pinkley 172.*

The pulp and seeds of *Solanum mammosum* are employed by the Kofán Indians to alienate cockroaches which often constitute a plague in their houses. This use is widely known, and the fact that the two names of the plant amongst the Kofáns are obviously borrowed from Spanish indicates that the plant has been a rather recent importation from elsewhere.

The Kofáns report the use of this plant as a "pacifier for small children" *(Pinkley 172).*

Solanum ovalifolium *Humboldt et Kunth ex Dunal,* Solan. Syn. (1816) 37.

COLOMBIA: Comisaría del Putumayo, Valley of Sibundoy, "Medicinal. Used for soap. *Gujaco; ujaco."* October 30, 1962. *M. L. Bristol 321.*

Bristol indicates that this plant is employed as a medicine in Sibundoy, but no specific illness has been cited.

Solanum platyphyllum *Humboldt et Bonpland ex Dunal,* Solan. Syn. (1816) 38.

COLOMBIA: Comisaría del Vaupés, Río Vaupés, Miraflores. January 29, 1944. *G. Gutiérrez et R. E. Schultes 706.* Comisaría del Putumayo, Río Sucumbios, Quebrada Conejo. "Fruit edible." April 2–5, 1942. *Schultes 2494.* Comisaría del Putumayo, road between Pepino and Mocoa, 700 m alt. July 28, 1960. *Schultes 22556.*

The fruit of this widespread species is edible. The plant is found semi-cultivated in all parts of the northwest Amazon.

Solanum scabridum *Dunal* in De Candolle, Prodr. 13, No. 1 (1852) 360.

COLOMBIA: Comisaría del Amazonas, Río Amazonas, Puerto Nariño. "Espina." October 14, 1972. *L. L. Glenboski C-91.*

According to Glenboski, the inhabitants of the Río Loretoyacu area of the Trapécio Amazónico make a decoction of the pith of the stem to treat earaches.

Solanum straminifolium *Jacquin,* Misc. 2 (1781) 298.

COLOMBIA: Comisaría del Amazonas. Río Caquetá, La Pedrera. April 1944. *R. E. Schultes 5883.* Comisaría del Vaupés, Río Apaporis, mouth of Río Pacoa. June 17, 1951. *R. E. Schultes et I. Cabrera 12586.* — Río Vaupés, Paracuara. November 27, 1952. *R. Romero-Castañeda 3777.*

The Kuripako name of this edible-fruited shrub is *mai-ya'-vee.* The Tukanos of the Río Vaupés know it as *eto-paa.*

The Miraña Indians who live near La Pedrera crush the leaves of *Solanum straminifolium* and apply them as a poultice to severe burns.

Solanum subinerme *Jacquin,* Enum. Pl. Carib. (1760) 15.

COLOMBIA: Comisaría del Vaupés, Río Vaupés, Mitú. "Height 4–5 feet. Flowers blue-purple. Weedy." September 27 October 30, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24244.*

Dragendorff test of the leaves of *Solanum subinerme* was positive for alkaloids.

Solanum Topiro *Humboldt et Bonpland ex Dunal,* Solan. Syn (1816) 10.

COLOMBIA: Comisaría del Vaupés, Río Apaporis, mouth of Río Pacoa. June 17, 1951. *R. E. Schultes et I. Cabrera 12602.*

The Kuripako Indian name of this widely cultivated edible-fruited species of *Solanum* is *ma-re'-da.*

Solanum verbascifolium *Linnaeus,* Sp. Pl. (1753) 184.

COLOMBIA: Comisaría del Putumayo, Mocoa. December 3–7, 1942. *R. E. Schultes et C. E. Smith 2035.* — Comisaría del Amazonas, Río Caquetá, La Pedrera. April 1944. *R. E. Schultes 5878.* — Comisaría del Vaupés, Río Vaupés, Cerro Mitú. "Herb up to 3 feet. Flowers white. Leaves used for washing; asperous." September 27–October 30, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24228.*

The leaves of this plant are asperous and cause an irritating skin rash and itching. They are strongly alkaloid-positive with a Dragendorff spot test.

Solanum sp.

The Kofáns, who know this *Solanum* as *toto-paje*, employ a decoction of the bark as an emetic *(H. V. Pinkley 480,* cited in Pinkley: loc. cit.).

Bignoniaceae

Pseudocalymma alliaceum *(Lam.) Sandwith* in Rec. Trav. Bot. Néerl. 34 (1937) 210.

Colombia: Comisaría del Amazonas, Río Amazonas, Leticia. Alt. 100 m. "Arbusto de 1.5 m, esteril. Olor fuerte aliaceo. Alcaloides: positivo. Nombre vulgar: *sacha-ajo."* October 8, 1961. *J. M. Idrobo 4687.*

Although this plant is alkaloid-positive with a Dragendorff test, the whole plant crushed and made into a tea is taken frequently to relieve pulmonary ailments by the people of the Leticia area.

No chemical studies of *Pseudocalymma* appear to have been published.

Acanthaceae

Fittonia argyroneura *E. Coemans* Fl. des Serres 16 (1865–1867) 103.

Ecuador: Napo, Río Aguarico, Dureno. December 21, 1965. *H. V. Pinkley 15.*

A cold-water infusion of a decoction of the whole plant steeped in water is used by the Kofáns as a rinse of the mouth and for toothache. The Kofán name of the plant is *minakoro-se-he´-pa.*

Rubiaceae

Arcythophyllum nitidum *(HBK.) Schlechtendal* in Linnaea 28 (1856) 492.

COLOMBIA: Departamento de Cundinamarca. Macizo de Bogotá, Quebrada Chicó, near Bogotá, 2700–2750 m. May 3, 1946. *R. E. Schultes et M. Villarreal 7096*. — Siberia. Páramo de Palácios, 9,000–10,000 feet. July 13, 1960. *R. E. Schultes 22477*.

The burning wood of this low shrub is said to give off a smoke that is extremely irritating to the membranes, causing painful swelling of the nasal passages.

Cephaelis barcellana *(Muell.-Arg.) Standley* in Publ. Field Mus. Nat. Hist. Bot. 8 (1930) 184.

COLOMBIA: Comisaría del Vaupés, Río Vaupés, Cerro Mitú. "Bracts red. Flowers yellow. Height 8 feet. In white sand." September 27–October 30, 1966. *R. E. Schultes, R. F. Raffauf et D. Soejarto 24222*.

All parts of this plant are alkaloid-positive with a Dragendorff spot test.

Duroia sp.

Amongst the Kofáns, who refer to the plant as *kayhi-chu-sehe'-pa*, a cold-water infusion of the stems is drunk as a cough remedy *(H. V. Pinkley 249, cited in Pinkley: loc. cit.)*.

Pentagonia sp.

The Kofáns are accustomed to place the pulp around the seeds into fresh cuts to keep the flesh from becoming infected. The Kofán name is *mankuyahet-chu-sehe'-pa (H. V. Pinkley 248*, cited in Pinkley: loc. cit.).

SAMBUCACEAE

Sambucus sp.

The Kofáns boil the young leaves and inflorescences to prepare a drink which is taken while hot for pains in the sides from coughing *(H. V. Pinkley 401*, cited in Pinkley: loc. cit.). The Kofán name is *sa-oco-sehe'-pa*.

Leucoanthocyanins (Gibbs: loc. cit. 2 (1974) 1266) and an alkaloid (Raffauf: loc. cit. (1970)) have been reported from the genus.

VALERIANACEAE

Valeriana longifolia *Humboldt, Bonpland et Kunth,* Nov. Gen. et Sp. 3 (1819) 330.

COLOMBIA: Departamento de Cundinamarca. Pantano Redondo, Zipaquirá, 3200–3250 m. July 13, 1960. *R. E. Schultes 22468.*

A tea prepared from the leaves of *Valeriana longifolia* is commonly used in the region of Zipaquirá as a kind of a panacea in folk medicine. It is especially valued as a stimulant for aged people.

An alkaloid—a derivative of actinidine—is reported from a species of *Valeriana;* tannins have also been indicated (Gibbs: loc. cit. 2 (1974) 1268; Raffauf: loc. cit. (1970)).

CUCURBITACEAE

Cayaponia glandulosa *(Poepp. et Endl.) Cogniaux* in De Candolle, Monogr. Phan. 3 (1881) 755.

COLOMBIA: Comisaría del Amazonas, Río Amazonas, Trapécio Amazónico. January 28–February 7, 1969. *T. Plowman, T. Lockwood, H. Kennedy et R. E. Schultes 2369.*

The leaves and young stems of this vine are dried and pulverized and employed in hammocks and cloths as an insect repellent. The fruit is chopped up, boiled in water and the resulting infusion is taken in the Leticia area for "liver complaints."

The vine is very abundant, forming great tangles on the riverside vegetation.

No active organic principle is known from this genus.

Cayaponia sp.

Stems of this species of *Cayaponia* are reportedly burned, and amongst the Kofán Indians the ashes are applied to external sores. The Kofán name of this vine is *chorok-o-pi-sehe'-pa (H. V. Pinkley 222,* cited in Pinkley: loc. cit.).

Campanulaceae

Centropogon solanifolius *Bentham,* Pl. Hartw. (1846) 139.

Among the Kofáns, this plant is "given to dogs" for an unspecified reason but possibly in the belief that their hunting prowess may thus be enhanced *(H. V. Pinkley 6,* cited in Pinkley: loc. cit.). The Kofán name is *ain-di-shi-sehe ′-pa.*

The chemistry of *Centropogon* is unknown.

Compositae

Senecio abietinus *Willdenow ex Weddell,* Chlor. And. 1 (1855) 100, 101.

Colombia: Departamento de Cundinamarca. Pantano Redondo, Zipaquirá, 3200–3250 m. July 13, 1960. *R. E. Schultes 22471.*

The resinous smoke from wood of this shrub causes a long-lasting burning sensation of the nose and mouth.

Many species of *Senecio* are alkaloidal (Wellaman and Schubert: loc. cit. (1961) 71–75; Raffauf: loc. cit. (1970)). Cyanogenic glycosides are frequent in the genus (Gibbs: loc. cit. 2 (1974) 1195).

PLATE 1

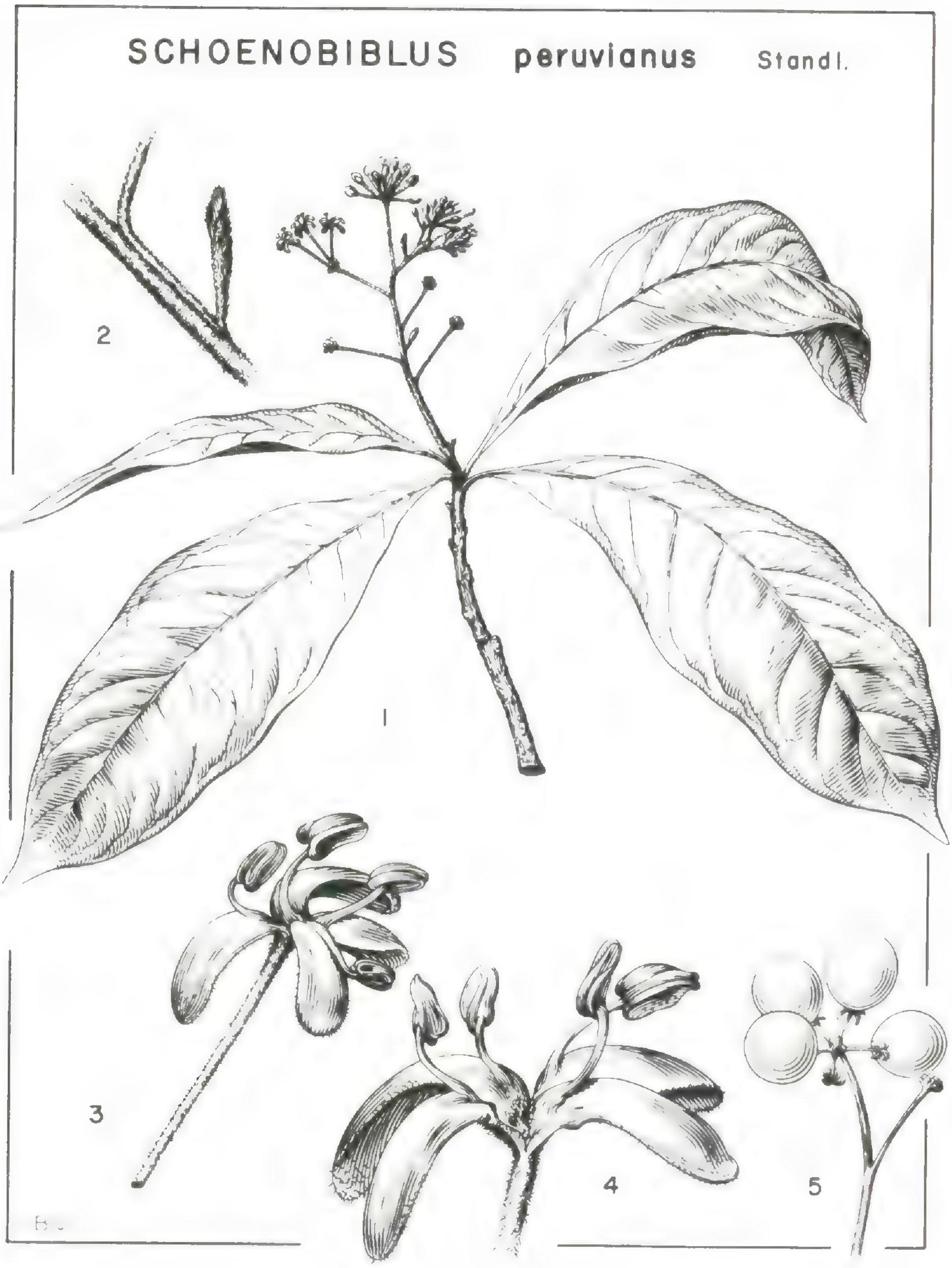
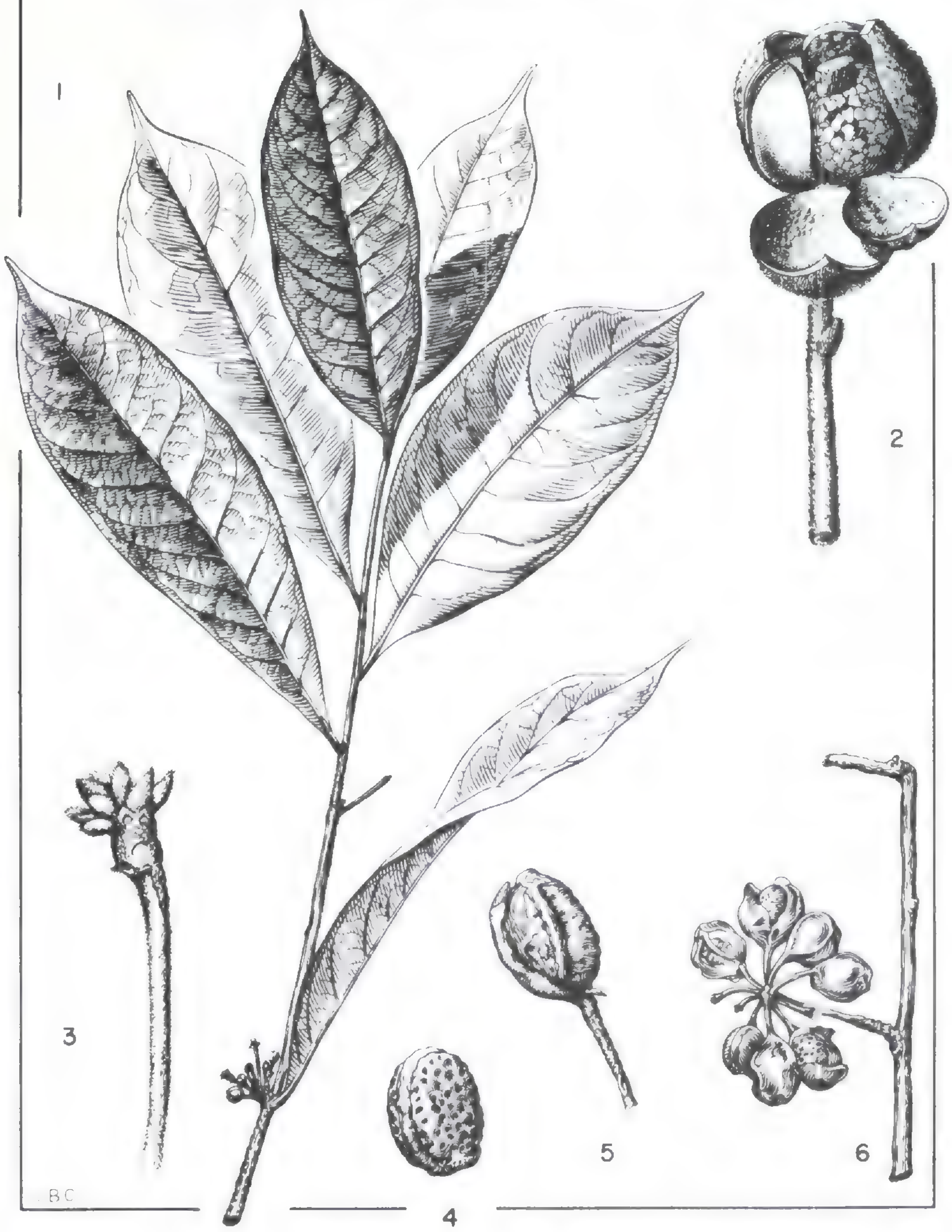


PLATE 2

UNONOPSIS **venificiorum** (Mart.) R.E. Fr.



BOTANTICAL MUSEUM LEAFLETS
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COCA IN THE NORTHWEST AMAZON

RICHARD EVANS SCHULTES

I.

The perspicacity in knowledge of psychotropic plants amongst the Indians of the northwest Amazon is uncanny. Even taking into account the millenia of living in intimate association with his ambient vegetation and his thousands of opportunities to learn through trial and error — even considering these circumstances, his achievements at bending the properties of plants to his use are astonishing.

There is little, however, that can compare with his use of the *coca* plant and its permeation into all of society and tribal customs. For throughout the northwestern Amazon, most Indian groups employ coca and have exalted it to a level never attained in the highland parts of the Andes, where its use has persisted from ancient times.

Coca is widely cultivated in the western Amazon, especially in Colombia, Ecuador and Peru. The type of coca cultivated in this vast region has been considered to represent a distinct variety: *Erythroxylon Coca* var. *Ipadu.** Some investigators believe that the coca plant and the use of the leaves as a narcotic are recent introductions to the western Amazon from the Andean highlands. The existence of a distinct variety of *E. Coca* and the deep magico-religious role played by this plant and its product in the northwest Amazon, however, would seem to indicate an appreciable age of the plant in the region as well as an antiquity for its use as a sacred narcotic.

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*According to the International Rules of Botanical Nomenclature, the correct orthography of the generic name should be *Erythroxylum,* even though the word is Greek and not Latin. This has been pointed out by Plowman in Taxon 25 (1976) 141-144 and in Botanical Museum Leaflets, Harvard University 27 (1979) 45-68. In this paper, nevertheless, I prefer to use the much more familiar and widely employed spelling *Erythroxylon.*

II.

The Tukanoan Indians of the Colombian Vaupés, for example, put the coca plant back into the very origin myths of the tribes. The Sun Father was a *payé*, a medicine-man, who originated the knowledge and power of modern payés. He had in his navel the powder of *vihó*, a narcotic snuff prepared from the bark-resin of trees of the myristicaceous genus *Virola.* A daughter of the Master of Game Animals owned *caapi,* the narcotic plant *Banisteriopsis Caapi.* Pregnant and in great pain, she lay down. An old Indian woman, in an attempt to help, took hold of her hand. The pregnant young woman broke her finger, but the elderly woman kept it and guarded it in the *maloca* or great round house. A youth, however, stole it and planted it. The caapi vine grew from this finger. Another daughter of the Master of Game Animals, also pregnant and in intense pain, lay down. An old woman came to help, but this time the woman seized the girl's hand and broke off a finger. She buried it. The finger took root and grew into the first coca plant.

Similar legends from many of the tribes of the northwest Amazon concerning the supernatural and ancient origin of *Erythroxylon Coca* might be repeated. All bespeak great antiquity.

III.

Erythroxylon Coca var. *Ipadu* is not known in the wild. It is cultivated, almost always in plots devoted exclusively to coca. The five- to eight-foot shrub is always vegetatively propagated: small pieces of the stem being inserted in the wet soil. Planted at the beginning of the rainy season, the shrub grows sparsely — the stems becoming often completely covered with lichens — and does not yield a harvest of leaves for 18 months. From then on, however, an individual shrub may yield for 20 to 30 years.

The coca plant is cultivated exclusively by men, as are other sacred plants such as caapi and tobacoo, and only men usually harvest the leaves. It is interesting to note this difference in agricultural practices in the northwest Amazon: cassava — which is rarely if ever planted together with coca — is cultivated, cared for and harvested always by women: coca, never. Further-

more, coca is almost never planted near the maloca and in the proximity of cassava and other food plants; it is cultivated in small plots, usually quite removed from the maloca.

IV.

Preparation of coca for use in the Amazon regions is very different from that commonly practiced through the South American highlands. The primary reason stems from the lack of easily available sources of lime in most parts of the Amazon.

The leaves are collected with great care by men from the coca-plantings and brought back daily to the maloca. Here they are toasted on a flat clay cassava-oven. This work, done by either a man or woman, consists of gently and constantly turning the leaves over, until all are dry and crisp. They are then put into a large mortar — a hollowed out log of some hard wood, frequently a species of *Tabebuia* or *Swietenia Mahogani,* but occasionally of the lower part of the trunk of the *chontaduro* or *pupunha* palm, *Guilielma speciosa.* Pounding is done with a pestle of hardwood, until the leaves are reduced to a fine powder. The mortar measures four or five feet in height; it must be long in order to impede the escape of the impalpable coca powder during the operation. The work of pulverization is done only by men who carry it out rigorously in a standing position. It may occupy up to an hour of pounding. The dull, rhythmic thumping which begins when darkness falls and may continue until nine o'clock is one of the hauntingly agreeable sounds that remains uppermost in my memory of many years of residence in the great malocas or round houses of the Indians of the northwest Amazon.

Whilst one man is pulverizing the leaves, another places a pile of dried leaves — usually of *yarumo* or *imbaúba* — on the floor in the middle of the maloca. He sets fire to these leaves, reducing them to ashes which are gently swept, when cool, into a small pile. The leaves of *Cecropia sciadophylla* are preferred. This tall tree is frequently left standing when the forest is felled for agriculture, since it is highly valued as the very best source of ashes for coca. Other species of *Cecropia* — *C. peltata* and *C. palmata* — are occasionally used, although they are much less

esteemed. The tree of second choice for this purpose is the cultivated fruit tree know as *uva de monte, curúra* or *mapatí (Pourouma cecropiaefolia)* which, as its specific epithet indicates, has a leaf resembling those of some species of *Cecropia.* Other plants may locally be employed in the preparation of ashes for coca. The Yukunas of the Río Miritiparaná of southeastern Colombia burn the bark of a species of *Styrax* (possibly an undescribed species) and add the ashes to coca powder for special festive occasions *(Schultes et Cabrera, 16708).* In the uppermost Río Negro, for example, the leaves of the *paxiú*ba palm *(Iriartea exorrhiza)* are valued; the Witotos of the Río Igaraparaná in Colombia esteem the leaves of another palm, the *rui-re'-gö* or *Astrocaryum Munbaca (Schultes 3885);* the Taiwanos of the Río Kananarí may occasionally — apparently for certain festivals — use the leaves of *Costus amazonicus,* which they call *ña'-ka.* These same Indians dry the leaves of *C. amazonicus* and *C. erythrocoryne* and use the powder to staunch nose-bleeds. They similarly employ the leaves of *Ocotea simulans* and the fruits of *Ocotea opifera,* which they assert makes the coca powder "stronger" for use in special dances. The leaves and twigs of the former species are slightly alkaloid-positive with Dragendorff reagent *(Schultes, Raffauf et Soejarto 24174);* the leaves of the latter species *(Schultes, Raffauf et Soejarto 24421)* are alkaloid-negative. The Kubeo Indians, who call the plant *ko'-ma-ma,* formerly employed the leaves of *Diplotropis Martiusii* to prepare an ash for mixing with coca powder *(Schultes, Raffauf et Soejarto 24389).* The Witotos of the Río Putumayo, the border area between Colombia and Peru, call *Stylogyne amplifolia (Klug 2148: Schultes 3989),* a member of the Myrsinaceae, *jipina coca, coca silvestre, taife jipina, taife diablo* and *tayfe heepeena.* These names suggest that this plant possibly served as an additive to or substitute of *Erythroxylon Coca* var. *Ipadu.*

Eventually, equal quantities of the green coca-powder and the grey ashes are thoroughly mixed. The mixture is then put into a small bag made of the pounded bark of a tree called *tururí* (species of either *Ficus* or of *Eschweilera*). A long stick is inserted into the bag as a handle and the mouth of the bag is

tightly bound around the stick. This sieve is then lowered into the mortar or, when it is available, into a five-gallon gasoline tin with a hole in the top and beaten, until the successive blows release all of the fine powder from the bag. The finely sifted powder, then ready for use, is put into a special calabash made of half of the hard rind of the fruit of *Crescentia Cujete,* known locally as a *cuya.*

Finely pulverized cassava-flour or fariña (*Manihot esculenta*) may occasionally be added to the coca ash powder.

V.

The use of coca in the northwest Amazon is restricted to the male sector of the indigenous population. Intensity of use varies from individual to individual and from tribe to tribe. Although it appears to have an essential and semi-sacred role in sundry ceremonies, it is employed hedonistically in daily life. Some Indians will take coca only in the afternoon or evening, but many keep the powder in the mouth throughout their waking hours and consume large amounts. During my long period of field work, I encountered its heaviest employment amongst the Yukunas of the Río Miritiparaná, where it was not uncommon to find men who daily used up to one pound of the powder.

In regions where acculturation has not progressed significantly — the Río Piraparaná of Colombia, for example — a visitor or stranger is made welcome with an offer of coca on the part of the head of the maloca.

A spatula made from the leg bone of the jaguar or a folded piece of the banana leaf are aboriginally used for transferring coca powder to the mouth, but now metal spoons may be employed.

A spoonful or two of the powder is put into the mouth. Conversation is impossible, until the powder has slowly been moistened and packed with the tongue between the gums and the cheeks. It is not chewed but is allowed gradually to mix with saliva and pass into the stomach. When the amount of the powder is thus diminished, it is replenished with an additional supply. Normally, a "quid" is kept in the mouth throughout the day.

There is here a very significant difference between the use of dried and entire coca leaves with an alkaline admixture in the highlands and the powdered product in the lowlands. In the highlands, the quid cannot be totally swallowed, but, in the lowland method of taking coca powder, most and occasionally all of the powder passes to the stomach. A recent study has shown how many nutritionally valuable elements are supplied by coca in the Andes. Since highland coca users eventually eject the quid from the mouth, the nutritionally valuable elements in the coca-alkaline preparation must be more available in a method of use in which the total leaf-alkaline preparation can pass through the whole alimentary canal. Unfortunately, nutritional studies parallel to those done for the highland use of coca leaves have not been carried out in the Amazon, but I have been convinced for many years that the use of coca as it is carried on in the Amazon plays a vital role in human nutrition. This aspect of *Erythroxylon* studies is in urgent need of investigation.

Coca powder has an initial bitter taste which puckers up the mouth. The first noticeable effect is a slight anaesthetizing of the tongue and mouth; this is followed by a general stimulation. Its value in some of the energetic dance festivals of the numerous tribes, requiring the expenditure of enormous amounts of energy, is obviously important. Furthermore, this stimulating effect makes its use, often in place of food, on long hunting or canoe trips away from the home maloca of the greatest physical help. The stimulation and capacity for performance and endurance which coca affords the individual and its ability to suppress hunger pangs gives the drug the role of an indispensible *vade-me-cum* in the more or less itinerant life of deprivation which many Indians of the northwest Amazon must undergo.

The use of coca is frequently referred to as "coca-chewing." No chewing is, however, ever involved in the northwest Amazon. The greyish green coca-ash powder is merely conveniently placed with the tongue, once the powder is wetted, between the cheek and the gums and slowly allowed to trickle down the esophagus. There is no word for this operation in English: the nearest, I presume, would be "to chew." Yet in South American Spanish, appropriate words exist: the verb *masticar* is never

employed for coca; in Colombia, there is a verb *mambear,* and in Peru, the equivalent term is *cacchar.*

I have used coca myself in my Amazon work with the Indians over a period of eight years and have never found it to be noticeably harmful. It is most certainly not addictive. Opinions amongst the field workers, however, may differ. The English plant explorer of the Amazon Richard Spruce — one hundred and twenty-five years ago — wrote: "I could never make out that the habitual use of *ipadú* had any ill results on the Rio Negro; but in Peru its excessive use is said to seriously injure the coats of the stomach, an effect probably owing to the lime taken along with it." The German ethnologist Theodor Koch-Grünberg, the only other scientifically oriented researcher to have spent long periods of time in the northwesternmost Amazon until the last few years, wrote simply that: "When used excessively, coca may be harmful to the nervous system."

Several other methods of coca use in the Amazon are to be noted. In both instances, however, much more field observation is necessary for clarification and understanding of these variants.

Koch-Grünberg reports that the Tukanoan Indians of the Río Papurí take an aromatic decoction of coca. Whether or not this usage is medicinal or merely a novel manner of utilizing the leaves for narcotic purposes he did not specify. The Panobos of Amazonian Peru drink coca on special occasions "to lighten the body."

There are vague reports from reliable scientific sources that, in certain annual ceremonies, the Yukuna and Tanimuka Indians of the Río Miritiparaná utilize the coca-ash powder as a snuff. There is no pharmacological reason to presume that a snuff of coca powder might not be biologically active. This report, though very significant, must be the subject of further investigation.

The preparation and use of coca in the Amazonian parts of Colombia vary little from tribe to tribe. My many years with the Indians of this region have uncovered only one significant variant. This discovery was made amongst an isolated group of Tanimukas who now live on a small affluent of the Río

Apaporis, the Igarapé Peritomé, which empties into the Apaporis slightly downstream from the great Cachivera de Yayacopi. These people have apparently long lived detached from the main body of the tribe, who live on the Río Popeyacá. In 1951, this isolated group numbered hardly more than 75 individuals. They appear to have fled into their jungle fastness some 50 years ago, rather than submit to enforced labour in the balata-forests.

Whether or not this novel method of preparing coca is an innovation of these Tanimukas or represents a vestige of a once more widespread culture trait surviving only in this small band cannot now be determined. But in my 14 years of living amongst the natives of the northwest Amazon, I never encountered this or any similar method of preparing the narcotic powder. It is noteworthy, nevertheless, that the Tanimukas of the Popeyacá, as well as Yukunas, Makunas and other neighbouring peoples, occasionally journey to the Peritomé Tanimukas, especially immediately before important dances or festivals, to purchase large supplies of the Peritomé coca. And this has continued apparently for many years, notwithstanding the fact that the necessary plant ingredients are to be found abundantly throughout the whole area.

The refinement, if it may be so termed, to which I refer lies in the use of the resin of a tree, *Protium heptaphyllum (Schultes et Cabrera 15681),* in preparing the usual coca-ash mixture.

Long and slender tubes or "cigarettes" of rolled and partly dried leaves of *Ischnosiphon* are tamped half full with small lumps of the brittle, whitish resin. The tip of that part of the "cigarette" containing the resin is lighted and brought to a glow by a gentle blowing through the tube.

In the meantime, several armfuls of dried leaves of *Cecropia* are set afire on the earthen floor of the house and reduced to ashes. The ashes are then scraped together into a small, more or less conical pile. Before the ashes are completely cooled, several men with resin tubes insert the glowing ends of the tubes into sundry places in the ash pile and blow vigorously. This process, which fills the house with a pleasant myrrh-like aroma, continues for seven or eight minutes or until most of the resin in the tubes is spent.

The ashes are then collected, sifted and added to an equal amount of sifted coca powder; the product is then ready for use.

The addition of the incense from *Protium*-resin alters appreciably the usual characteristic taste of the coca, giving it a balsamic savour. There is no evidence that the incense either heightens or lessens the normal narcotic effects of coca prepared in the usual manner as a powder. It seems obvious that the only reason underlying this process is to effect a change in taste.

Thoroughly accustomed though I was at the time to the use of coca, I found that this resin-treated product usually caused irritation of the mouth and throat the first day of its use. This irritation, due undoubtedly to the balsamic smoke absorbed by the ash particles, disappeared upon continued use of the coca.

Inquiry indicated that the resin of *Protium heptaphyllum* is the only one of the many balsamic exudations of plants of the Amazon forest cosidered to be suitable for flavouring coca. The Indians insist that resin for this purpose must be gathered exclusively from old trees, but why younger trees must be avoided could not be explained. Incisions are made in the bark, and the resin is allowed to dry on the trunk before being gathered and wrapped up in leaves in small packets which are hung under the rafters of the house to "age" for four or five months before using.

The genus *Protium,* a member of the Myrrh Family or Burseraceae, is the source of several commercially and medicinally valuable resins. Resins from related genera have likewise enjoyed economic importance. The resin of *Protium heptaphyllam,* usually called *brea* or *pergamím* in Colombia, is commercially known as *taca-mahaca gum.* These vernacular names may occasionally be applied, however, to other burseraceous resins. *Protium heptaphyllum,* which in the Tanimuka language is referred to as *hitamaká*, yields a hard, translucent whitish resin that easily fractures; it is distinctly pungent, even when old and dried. Its properties are similar to those of other terebinthinates. It is chemically made up of 30% protamyrine, 25% proteleminic acid, 37.5% proteleresin, as well as several minor constituents.

VI.

There are sundry substitutes for coca in the northwest Amazon. Probably a relatively large number of plants are involved, but only a few are known and have definitely been identified.

Amongst the Witotos and Boras of the Río Ampiyacu of Amazonian Peru, for example, at least two wild species of *Erythroxylon* are employed when, as the natives say, "there is no coca available." These two species are *E. fimbriatum (Plowman, Schultes et Tovar 6878)* and *E. macrophyllum (Plowman, Schultes et Tovar 6879).* Amongst the Kubeos of the Río Vaupés of Colombia, *E. cataractarum* (Schultes, pers. obs., no voucher specimen) may be used in lieu of real coca, even though there is no evidence of cocaine in this species.

According to Zarucchi *(Zarucchi 1383), E. cataractarum* is known in the Río Kuduyarí area of the Vaupés as *coca de pescado,* undoubtedly because the fruit is eaten by fish as it drops in the river from the trees along the edge of the rapids. It is "almost as strong as 'cocaina' and is used by people who do not have a coca patch." It is said to be a "very strong wild coca, one of the wild cocas used prior to the introduction of cultivated varieties; presently, the cultivated is preferred, because it is not so strong." Another collector, Davis *(Davis 151),* reports that the Barasana Indians of the Río Piraparaná maintain that "this coca can be eaten" and that "it was the coca of our fathers."

Curiously, three apocynaceous plants were found to be so employed amongst the Witotos and Boras of the Río Ampiyacu. The leaves of the large and well known tree *Couma macrocarpa* (Plowman, Schultes et Tovar, pers. obs.; no voucher specimen), source of a latex valuable as gum and known in Brazil as *sorva,* in Colombia as *juansoco,* are so employed. Two species of *Lacmellea—L.* cf. *peruviana (Plowman, Schultes et Tovar 6653)* and *L. lactescens (Plowman, Schultes et Tovar 6889):* the former is used primarily when Indians are working in the forests and their supply of coca runs out: branches of the latter are tied up over the fire to dry and smoke, and the leaves are then powdered like coca and mixed with *Cecropia* ashes.

VII.

Several plants are medicinally involved in treating problems thought to be concerned with use or overuse of coca. The Indians living near Mitú on the Río Vaupés of Colombia powder the bark of *Tachigalia cavipes (Garciá-Barriga, Schultes et Blohm 16061)* and employ it to "dry up" cancres of the mucous membrane of the mouth, caused presumably by excessive use of coca.

The Barasanas of the Río Piraparaná of Colombia are heavily habituated to coca. Aged men of this tribe frequently suffer from stomach or intestinal bleeding, a condition which, although it might have sundry causes, they attribute to long and excessive use of coca powder. In an effort to alleviate this trouble, they recommend a hot tea of the leaves and bark of *Pagamea macrophylla (Schultes et Cabrera 17581).* The leaves of *P. macrophylla* are also pulverized and aspirated by the medicine men during ceremonies of divination.

Coca leaves enter into medicinal preparations with other plants in several localities. They are boiled with the leaves of *Vochysia laxiflora (Schultes et Cabrera 16676)* to prepare a tea when urination is painful or difficult.

Amongst the Witotos of the Río Karaparaná of Colombia, the dried and powdered root of *Chelonanthus alatus (Schultes 3805)* is added in very small amounts to the coca-ash powder "to give it a bitter taste." It appears that this practice is followed infrequently and may be associated with certain ceremonies, when a special kind of coca is desired. A tea of the root is also employed as a wash for infected wounds. This gentianaceous species, known in Witoto as *ho-ko-só-gö-nö*, has, like so many in the family, bitter principles.

VIII.

There is obviously much that remains to be investigated along interdisciplinary lines on the use and significance of coca in the

northwestern Amazon. It is an area where coca retains its traditional cultural significances and where a number of variations in its use and in the plants which may serve as surrogates or with which it may be employed have persisted. Furthermore, it enters very materially into native medicinal practices. All of these special characteristics of its utilization and the discovery that in this region a distinct variety of *Erythroxylon Coca* exists, would seem to bespeak great antiquity of use and make an intensive study of the plant in the northwest Amazon an investigation of high priority.

IX.

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ERYTHROXYLUM Coca Lam.
var. Ipadu
Plowman

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LEAF VARIATION AMONG CANNABIS SPECIES FROM A CONTROLLED GARDEN

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The genus *Cannabis* has had a long association with man and contains considerable variation in growth form, achene size, and chemical content. The variation has taxonomically been variously interpreted. Some maintain the genus is polytypic with at least three species (Emboden, 1974; Schultes *et al.*, 1974). Others (Small and Cronquist, 1976) believe that it is properly viewed as monotypic: *i.e.* limited to *C. sativa* L. They do, however, recognize several infraspecific varieties.

Historical aspects and rationale for the different treatments are amply covered in these papers.

My work on wood anatomy (Anderson, 1974) supported the polytypic generic concept. A controlled garden (2.6 acres) is maintained at the University of Mississippi by the School of Pharmacy for the National Institute on Drug Abuse where collections from throughout the world are propagated. In 1976, I visited the facility several times to obtain additional vouchered wood samples from plants grown in a uniform garden. While gathering the *Cannabis* samples, I became aware of differences in leaf morphology. Variation in garden-grown plants has already been noted by Quimby *et al.* (1973), but they did not quantify their data. This report analyzes leaf form in *Cannabis* and compares the variation in relation to the alternative taxonomic treatments.

METHODS AND MATERIALS

Measurements were made from the largest leaf on each voucher specimen. Dimensional data were taken from the central (longest) leaflet. Measurements as illustrated in Fig. 1 included leaflet

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length (L), leaflet width and length to the widest point. Ratios of width to length (W/L) and length to widest point to total length (WP/L) were determined. Leaflet number, plant height and sex of the sample were also recorded.

Statistical analyses were made with assistance from Dr. David Schrader; these analyses of all materials are on file at Florida State University. Ken Womble and Melanie Darst helped with graphics.

A total of 377 samples were measured. Most materials came from the Mississippi garden. The University of Mississippi School of Pharmacy and Dr. C. E. Turner are thanked for making their facilities and the plants available. Some garden plantings were maintained for several generations: therefore, samples were taken only from original seed sources to prevent possibility of garden hybridizations. I collected sixty specimens representing thirty-nine different seed sources. That somewhat extensive population sample was augmented by the intensive sampling from the garden in 1972 by Dr. R. E. Schultes and his colleagues (with 237 specimens from thirty-two seed sources). Vouchers are preseved at the Florida State University and the Botanical Museum of Harvard University, respectively. An additional eighty specimens from different wild or naturalized populations were studied at the Gray Herbarium and Arnold Arboretum.

RESULTS

Samples were placed in four categories based mainly on growth form. The three major forms are illustrated in Fig. 2. Those classed as *C. sativa* were taken from tall, laxly branched plants (S, in the tables). Relatively tall plants with very narrow leaflets and small achenes were classed as *C. sativa,* small-seeded (SS); short, compact plants that were densely branched were classed as *C. indica* Lam. (I); and those mature plants that were two feet tall or less and unbranched, as *C. ruderalis* Janisch. (R).

Mean data for leaf morphology for the four categories and three collection sets are given in Table 1. The four categories in my 1976 sampling were all significantly different for W/L and

WP/L at the 99.9% level of confidence, as determined by a Student's *t*-test. Statistical analyses were not made on the other sets, due partly to absence of garden material of *C. ruderalis* in 1972.

Garden plants maintained their relative growth patterns: *i.e.*, height and branching; but leaves were noticeably larger under cultivation (compare 1976 and 1972 versus "wild" in Table 1). Although leaves were larger, dimensional ratios of the central leaflet (W/L and WP/L) did not vary significantly between garden-grown and wild samples.

Massed data for all three collection groupings are given for the four categories in Table 2. None of these categories is significantly distinct for leaflet length, although *C. ruderalis* consistantly has small leaves. The small-seeded, narrow leaved *C. sativa* (SS) from India and Pakistan is not so significantly distinct from *C. sativa* (S) as is *C. indica.* No formal infraspecific status is proposed for those small-seeded plants, but further study is warranted.

The three species, *C. sativa, C. indica,* and *C. ruderalis,* are well defined in leaflet width/length ratios, and the latter two are also distinguished from *C. sativa* in their oblanceolate leaflets (WP/L). Leaf morphology groupings reported here are compatible for those of the holotypes of *C. sativa* and *C. indica;* the type specimen of *C. ruderalis* was not available for measurement.

Modal leaflet number for *C. sativa* was 7 with a mean of 6.35. Leaves of *C. indica* had a mode of 9 (mean, 8.20), and *C. ruderalis* had a modal leaflet number of 5 (mean, 4.59). No significant differences were found in leaf morphology between sexes of a given species, but in a few populations the female plants had wider leaflets than did the males.

Leaf character sets were generally reinforcing: *i.e.*, leaves of *C. indica* that were unusually narrow and thereby somewhat like those of *C. sativa* were also very oblanceolate. The most nearly intermediate leaf morphology was found in a stout Japanese cultivar of *C. sativa* with W/L = .143 and WP/L = .524. It was unique in having smooth stalks (few if any trichomes) and no THC content. Multivariate analysis would have dramatized the distinctness of the foliar characteristics of the species more completely, but *t*-tests were considered ample.

Table 1. Mean measurements for leaf morphology in *Cannabis.**

Group	Collection set	Leaf Features L (mm)	W/L	WP/L
C. sativa (S)	1976	131.7	.133	.460
	1972	128.5	.108	.420
	wild	114.2	.110	.423
C. sativa (SS)	1976	93.0	.101	.505
	1972	90.9	.094	.422
	wild	65.4	.097	.402
C. ruderalis (R)	1976	67.1	.163	.536
	1972	—	—	—
	wild	59.5	.214	.517
C. indica (I)	1976	143.3	.207	.578
	1972	118.3	.172	.560
	wild	83.6	.214	.579

*See text and Fig. 1 for key to leaf features; *C. ruderalis* was not grown in the garden in 1972.

Table 2. Combined set mean data* for leaf morphology in *Cannabis*

Leaf Feature	C. sativa (S)	C. sativa (SS)	C. ruderalis (R)	C. indica (I)
L	125.9	78.8	61.8	117.0
W/L	.105	.094	.203	.182
WP/L	.436	.426	.523	.565

* Means connected with ═══ are not significantly different (p = >.1)
Means connected with ——— are significantly different at p = .1–.05
Means not connected are very significantly different at p = <.01

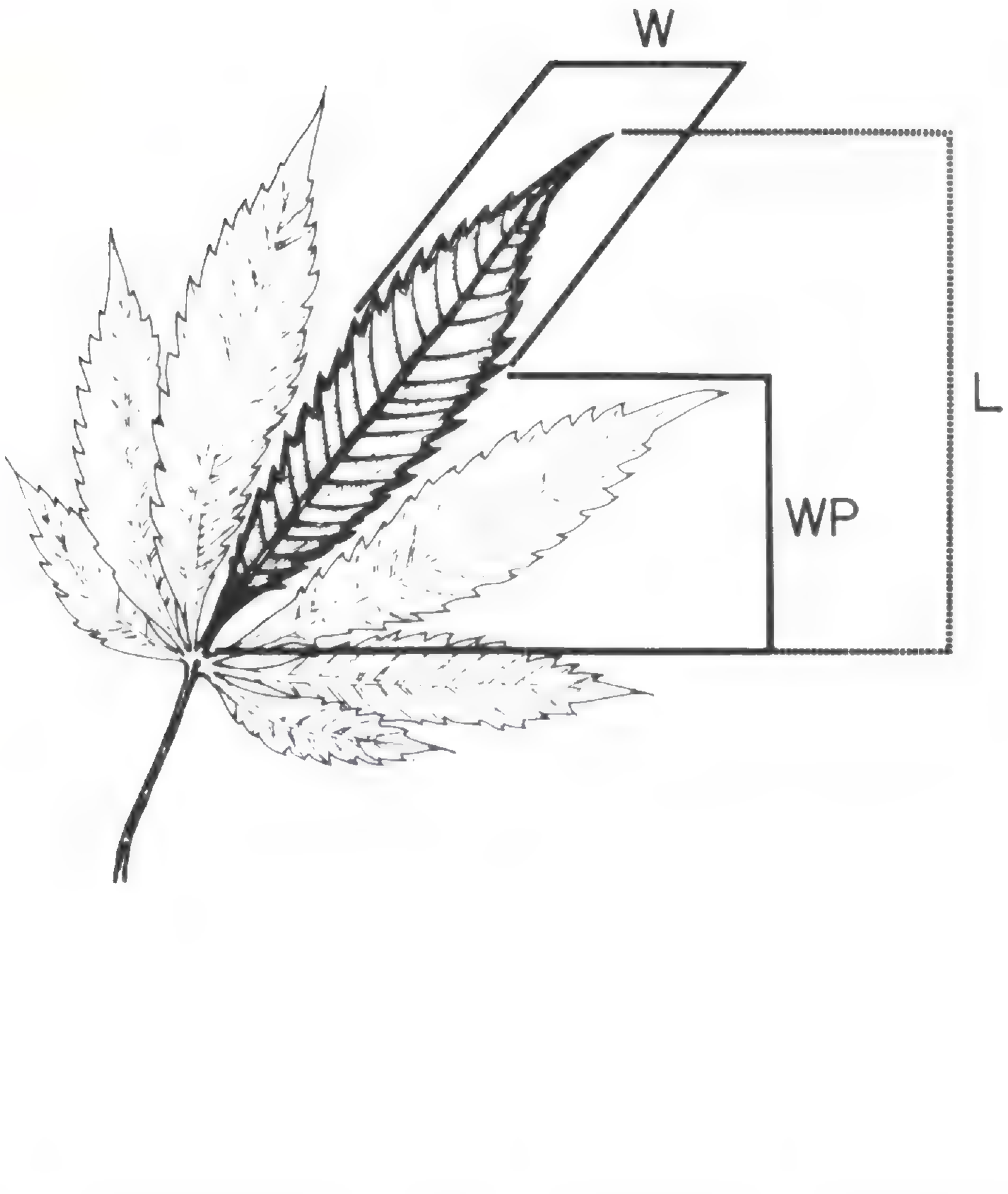

Fig. 1. Tracing of leaf of *C. indica* from plant grown in garden from seed from Afghanistan *(Anderson 4390;* garden accession AF-G), showing measurements made on central leaflet. L = leaflet length, W = width, and WP = length to widest point of leaflet. The ratios of W / L and WP / L for the various sets of plants are given in Tables 1 and 2.

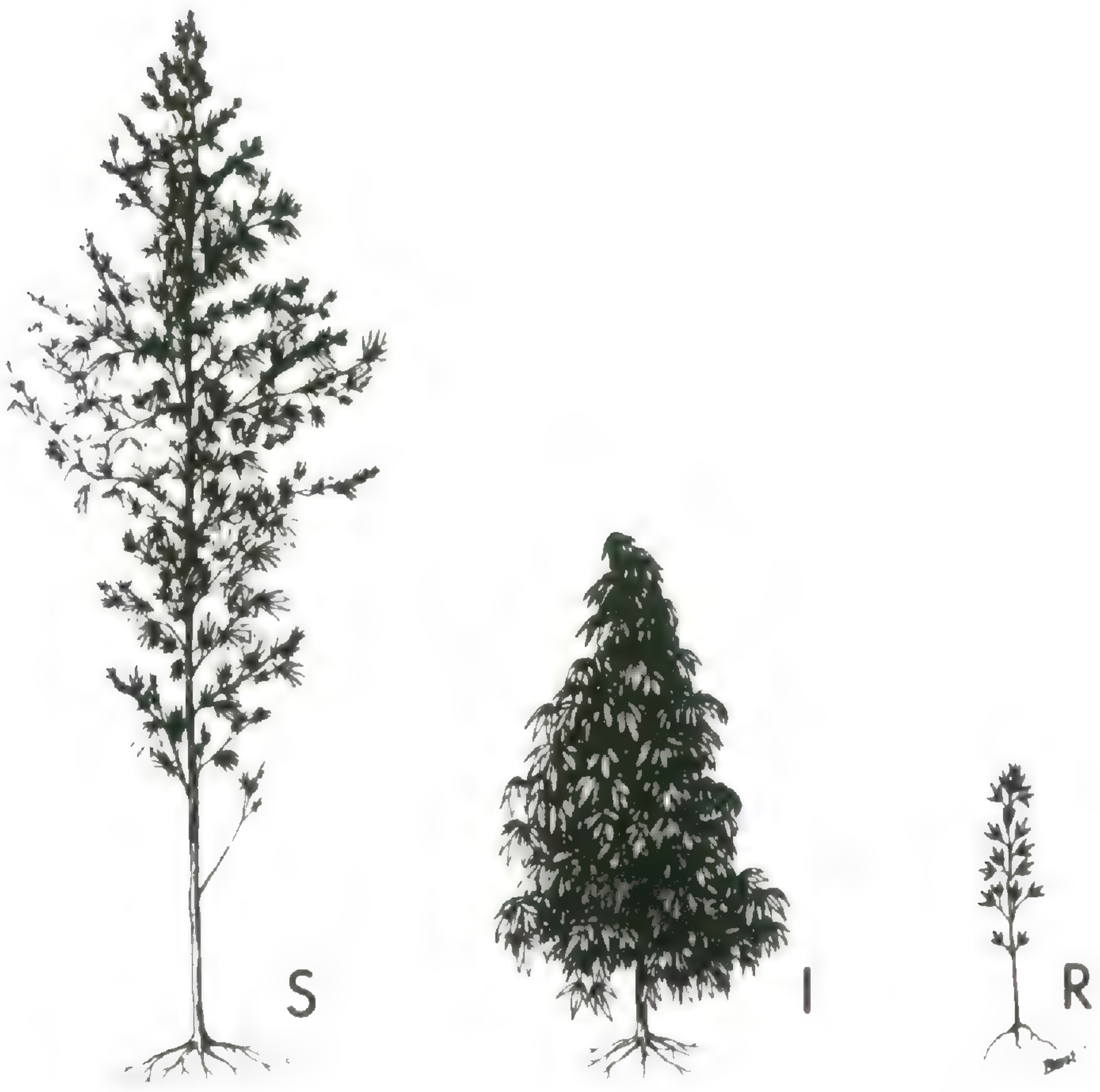

Fig. 2. Growth patterns in *Cannabis* species; S = *C. sativa,* I = *C. indica,* and R = *C. ruderalis.* Plants drawn with representative heights of eight, four, and two feet, respectively.

DISCUSSION

Differing views on the taxonomy of *Cannabis* have generated much interest—perhaps more so in forensic circles than in scientific settings. Still, species delimitations should be determined on the plant biology rather than on legal implications or societal needs (c.f., Small, 1975).

Leaflet morphology and number do correlate well with the distinctive growth forms of the species (Fig. 2). Three major groupings of features are found, and each represents a named species. They are as follows:

1. **Cannabis sativa:** Plants relatively tall, 5–18 feet tall or more, laxly branched; leaves usually palmately compound with (3) 5–7 (11) leaflets, central leaflet lanceolate with W/L ratio (.05) .09–.12 (.15). Environmentally induced unifoliate (simple) leaves of garden plants from Thailand were also narrowly lanceolate.
2. **Cannabis indica:** Plants short, 2–4 feet tall, pyramidal, compactly branched; leaflets (5) 7–11 (13), central leaflet oblanceolate with W/L ratios (.14) .17–.21 (.35).
3. **Cannabis ruderalis:** Plants (female) very short, 0.5–2 feet tall, usually unbranched; leaflets 3 5 (7), central leaflet elliptic with W/L ratio (.10) .16–.21 (.45).

Plant heights given are those under normal conditions; *C. sativa* can be photo-induced to flower in the seedling stage. These three complements of characteristics are found in wild or weedy settings and are maintained in the uniform garden. None of the features appear to be simply environmental variants.

Features of wood anatomy also distinguished *C. sativa* and *C. indica* (Anderson, 1974). Study of the woods of garden samples is nearly complete. The additional samples are corroborative for those two species, and *C. ruderalis* wood is intermediate to that of the other two species but distinctive.

Other features such as plant odor, leaf color and leaflet serration pattern may prove to be of taxonomic value, but they were not quantified in this study. Similarly, seed (achene) features may be helpful, but I did not collect seeds. Earlier taxonomic

applications of achene data are contradictory (Emboden, 1974; Small and Cronquist, 1976).

Recent proponents of the monotypic view of *Cannabis* (Small and Conquist, 1976) emphasize chemical data and interfertility of the plants. Data from hybridization experiments are sometimes over-emphasized. Those which can be achieved through artificial hybridization in the garden or greenhouse often give an exaggerated view of biological interactions among natural populations. In general, interspecific hybridization is a relatively frequent phenomenon (Knoblock, 1959), especially so in wind-pollinated species such as *Cannabis*. The ability to hybridize or not is not recommended as a sole or major species criterion, because the degree of fertility among interspecific hybrids varies widely (Stace, 1975). This is particularly true for many weedy plants (like *Cannabis*); Baker (1972) states: "A full spectrum of interspecific hybridization can be seen in the world's weed flora, from the formation of sterile F_1 hybrids to the production of vigorous, fertile amphidiploids or significant introgression."

Species of *Cannabis* are not mutually exclusive in their cannabinoid content, and cannabinoids are known to fluctuate in quantity and composition during the life cycle of the plant. Consequently, a study group sponsored by the United Nations Narcotics Laboratory (1976) stated that "cannabinoid composition can serve only as a limited chemotaxonomic tool." Turner *et al.* (1973) demonstrated that cannabinoid composition is not stable in stored plant material, and Turner (pers. comm.) has noted daily fluctuations in cannabinoid content in living plants. Therefore, a single plant might be classified with Small and Cronquist's key (1976) as *C. sativa* ssp. *sativa* at one time of day and as *C. sativa* ssp. *indica* at another time of day! Clearly the use of chemical data as primary taxonomic criteria (Small and Cronquist, 1976) is neither practical nor natural and has been duly criticized by Emboden (1977).

Judging from Small's annotations on herbarium sheets, his predilection to classify plants by intoxicant ability and/or geographical distribution has resulted in placing many plants of *C. sativa* in with *C. indica*. Consequently, the two groups would then not represent distinctive morphological forms (perhaps this contributed to his recognition of the groups as subspecies rather

than species). My circumscription of *C. indica* is narrower than that which constitutes *C. sativa* ssp. *indica* (Lam.) Small & Cronquist. Thus, it should be noted that studies based on material supplied by Small (such as Clark and Bohm, 1979) would reflect his wider interpretation of *C. indica* as a subspecies of *C. sativa.*

The genus *Cannabis* might best be described on morphology rather than chemical composition as having three closely related but distinct species: *C. sativa, C. indica,* and *C. ruderalis.* One species, *C. sativa,* itself is extremely variable, having been domesticated by early man for use as food, fibre, oil, medicine, and hallucinogen.

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BIOGEOCHEMICAL RESIDUES AS ETHNOBOTANICAL INDICATORS[1.]

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In America, the archaeological application of chemical residue analysis of the soil is really in its initial stages. Soil phosphate analysis has been the dominant method used to date, although there is occasional use of other parameters, such as pH by Weide, (1966) and the now classical C, N, P and Ca analysis of Cook and Heizer (1965).

Sjoberg (1976) has said:

> "Phosphate analysis is not only suitable for locating and delimiting sites, but can also serve as a useful tool in the interpretation of intrasites relationships. Experimentally, the P content has been used in estimating population size and the duration or intensity of settlements; to determine subsistence base and describe general diets; and to establish relative or even absolute chronology."

This paper proposes to expand the data base of soil residue analysis, particularly with respect to plant residue, by suggesting a new method of *Trace Typing* which utilizes a measurement of Trace Element Concentration (T.E.C.) and an associated new parameter of Enrichment Ratio which employs dendrochronologic data and contemporary botanicals.

The development of this *Trace Typing* has been motivated by the concern that much evidence has been screened out on the back dirt of the archaeological site.

Increasingly we see the need to verify specific functional attributes to sites, features, tools and other items. Although macroscopic evidence is usually employed to test the validity of a

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proposed attribute, soil residue analysis potentially can be used to gain clearer or more complex additional data.

Recent works on organic residues are very promising. Rottlander and Schlichterle (1979) have successfully used gas chromatography and thin layer chromatography to identify residues of plants and animals on a series of sites including an open air Aurignacian loess site some 34,000 years old. Pollack, Chang, and Cronin (1977) have reported on the determination of D and L isomers of some protein amino acids present in soils.

It does appear that organic residue analysis offers promising possibilities in approaching the archaeological site.

We are concerned with focusing on the examination of inorganic elemental components of site residues. Our preliminary findings suggest the potential of using elemental analysis to identify vegetal remains. If we are to expand the data base to include inorganic components of residues, there are three major questions to be asked.

1) What elements will be useful to examine?
2) What is the significance of elemental concentrations?
3) What type of strategy can be applied to implement this research?

1) WHAT ELEMENTS SHOULD BE EXAMINED?

Obviously, we would like to examine elements which have low mobility within the soil profile under a variety of conditions. The field of geochemistry has been concerned with the mobility of elements in biogeochemical prospecting.

The mobility of elements determines their creation of a dispersion halo around an ore body. For our purposes, this information can be used to select suites of elements having low mobility.

Andrew-Jones (1968) described the relative mobilities of elements in a low temperature and pressure environment. In Table One, we have listed the elements which have low mobility (barred) and those having very low mobility to being immobile (stippled).

These elements should remain in the soil as residues under oxidizing and reducing conditions, and under acid, neutral to

alkaline soil conditions. Table One indicates that there are 40 elements which should be retained with the soil profile.

Mobilization of elements is strongly influenced by Eh (ionization potential), pH and the stability of minerals within the soil.

Brooks (1972) described four main factors responsible for mobilization and distribution of the elements.

1) Mobilization due to breakdown of soil by weathering and leaching.
2) Adsorption of ions on clay minerals and humus. Clay has an ion exchange capacity of up to 100 meq/100g; humus has a 500 meq/100g capacity.
3) Surface enrichment of elements by plant material. Here plants cycle particular elements by absorping from the soil, incorporating into their tissue, and enriching the surface by littering. The humus layers will be enriched relative to the stability of metal complexes with organic matter.
4) Mobilization or fixation by soil micro-organisms, particularly bacteria. Although insignificant in weight, their metabolic processes effectively handle large quantities of material.

Given these four factors, we may immediately realize that there will be chemical partitioning between the mobile and immobile elements and the efficiency of chemical traps.

Notwithstanding the problems of mobility, there are 40 elements which may be useful in interpreting plant residue.

2) WHAT IS THE SIGNIFICANCE OF ELEMENTAL CONCENTRATIONS?

As a plant seeks to establish itself, it employs the following methods with respect to the elemental composition of the soil.

—First, it demonstrates an exclusion mechanism through which qualitative and quantitative regulation of absorbed elements is accomplished. This mechanism occurs primarily at the roots, although it may occur somewhat in the canopy.

—Secondly, this action of elemental uptake is related to function, and that function is the production of compounds. These compounds range from metabolic intermediates, various vitamins and catalysts through pigments such as chlorophyll to particular enzymes such as those associated with respiration and membrane repair.

Some additional compounds produced demonstrated a "social" function, like those that promote mutualism, such as insect

attractants for pollination purposes, for transmittance of seeds through edible fruits, or by cultivation for economic purposes that is food, medicinal, or industrial use.

Other compounds socially "protect" by repelling insects, fungus, herbivorous animals and man.

—Thirdly, in the event that the exclusion mechanism fails, or is overloaded, extraneous elements are translocated to the canopy, where exfoliation effectively provides elimination.

Hyper-accumulation has a number of promoters: e.g., overwhelming of the exclusion mechanism by very high concentrations demonstrates itself in geochemical prospecting indicators of ore deposits.

Metabolic disorders brought about about the first notice of hyper-accumulators by Agricola in 1467 in *DE RE METALLICA*. Agricola described the hyper-accumulators as "sick-looking plants".

Pathologies of respiration, insect or fungus infestation, and tissue degeneration demand the heightened production of the necessary remedial compounds. In the event that the remedial agent cannot keep up with the disease, we are likely to see, in fact, actual deposition of the element at the site of the pathology.

Stress is also a promoter of hyper-accumulation. Plants have been shown to hyper-accumulate as a result of stress induced by alternately subjecting the plants to nutrient-rich and nutrient-poor growth solutions.

This factor of environmental stress occurring to all plants in a particular ecosystem may display an overall pattern of hyper-accumulation as the community seeks to establish itself.

In response to a reduction in soil pH, and thus increased availability of elements for uptake, one would expect a corresponding increase in uptake by plants.

Whatever the elemental accumulation, it becomes a factor in the identification of residues and in linking them to their source.

3) WHAT TYPE OF STRATEGY CAN BE APPLIED TO COMPLEMENT THIS RESEARCH?

Wood and other plant materials such as gums, resins, reeds, grasses having use in construction and deposits of foods,

medicinals, or cosmetics found at domestic, agricultural, religious or other types of archaeological sites could be identified by elemental pattern; with the residue being related to a source (ancient or modern) displaying the same pattern of elements similar to the matching of a blood or tissue type.

This *Trace Typing* of archaeological residues within the perimeter of a site can be accomplished by the following method.

TRACE TYPE METHODOLOGY

1. Establish perimeter of the site utilizing:
   a. Direct observation
   b. LAND SAT
   c. Infrared spectrometry or photometry.
   d. Search for anomolous concentrations in the leaf canopy such as that used in biogeochemical prospecting.
2. Feature location utilizing a larger rectangular grid of 5 x 5 meters or a relative size appropriate to the site and testing for:
   a. Magnetic anomalies (magnetometer)
   b. pH (probe:meter)
   c. Conductivity (probe:meter)
   d. Phosphates (chemical field kit)
   e. Total Organic Carbon (laboratory or field lab)

   Plot these results and produce contour maps.
3. Where anomalies occur, such as:
   a. Low pH
   b. High magnetic anomaly
   c. High phosphate
   d. High conductivity
   e. High total organic carbon (TOC)

   Take additional samples in these areas of anomaly. At this point, the grid size and the sampling strategy can be changed, as well as using a 3-D sampling array. This will give the structure of the features through chemical detection.
4. The *Trace Typing* of organic residues or soils from features should be done with particular reference to the major essential biogenic elements with low mobility namely P,

Mn, K, Fe. This is a necessary voluntary restriction to provide a pool of elements that demonstrated the most stability in a dynamic and evolving mutualism between the inorganic and organic, the non-living and living interface.

5. Elemental analysis of non-anthropogenic soil samples off-site will provide a background with which to compare the ASH and organic residue samples. If ash or residue element levels are greater than that of the soil background levels, then the following calculation can be made:

$$\frac{\text{X}-\text{Soil}}{\text{Soil}} = \textit{TRACE ELEMENT CONCENTRATION} \text{ (T.E.C.)}$$

Where X=ASH, or organic residue concentration level.

6. We propose the idea of *Trace Type*. That is, then, a series of 5 T.E.C. measurements typifying a given feature. They are:
   a. PO_4
   b. Mn
   c. K
   d. Fe
   e. Hyper-accumulating variable(s)

   It is the Total *Trace Type* that must be utilized in standardization and comparison to residues within the site and to other reference materials.

7. Once the structure of the feature is established, one can potentially interpret or ascribe function(s) to the feature, relative to plant use. This is particularly feasible in cases where there was low plant diversity and use of hyper-accumulating plants. The soil background samples and those of the feature are analyzed by neutron activation analysis, using the 40 low mobility elements, if detectable. In turn, ancient and modern species are analyzed, utilizing available ethnobotanical evidence of species identified within the feature or site. A comparison of the results will allow one to specify the nature of plant utilization.

8. If there are primary trees that appear to have been in residence during site occupation, they should be cored and

submitted for dendrochronological analysis and then further analyzed by neutron autoradiography. This may show details of occupational chronology by hyper-accumulation of trace elements in the tree through time. High levels suggest site occupation, low or diminishing levels unoccupied periods of time.

9. Additional calculations can be made from dendrochronological data (Tree Rings) and from the *Trace Type* of the contemporary canopy.

$$\frac{TOTAL\ T.E.C.\ DEND.\ DATA}{TOTAL\ T.E.C.\ SOIL} \quad [\quad \text{Enrichment Ratio D (Dendro)}$$

$$\frac{TOTAL\ T.E.C.\ CANOPY}{TOTAL\ T.E.C.\ SOIL} \quad [\quad \text{Enrichment Ratio C (Canopy)}$$

This Enrichment Ratio is indicative of the flow rate of the cycling process between elemental uptake and elemental return.

A comparison of modern enrichment processes Enrichment Ratio C compared to past ancient enrichment levels Enrichment Ratio D should bring greater understanding of the ecological conditions and of site occupations at particular locations.

We introduce these measurements of Trace Element Concentration (T.E.C.), of *TRACE TYPING* and of the Enrichment Ratios to stimulate the building of a data base that draws on both ancient and modern materials and that promises to give rise to not only ethnobotanical identifications but to a greater and deeper understanding of plant utilization and transport with respect to archaeological sites.

We look forward to examining the evidence for plant utilization on occupation sites, resulting in biogeochemical residues in the soil. If there are specific patterns of accumulation of elements in plant materials, then these patterns will be useful in interpretation.

ACKNOWLEDGMENTS

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PERIODIC TABLE OF THE ELEMENTS

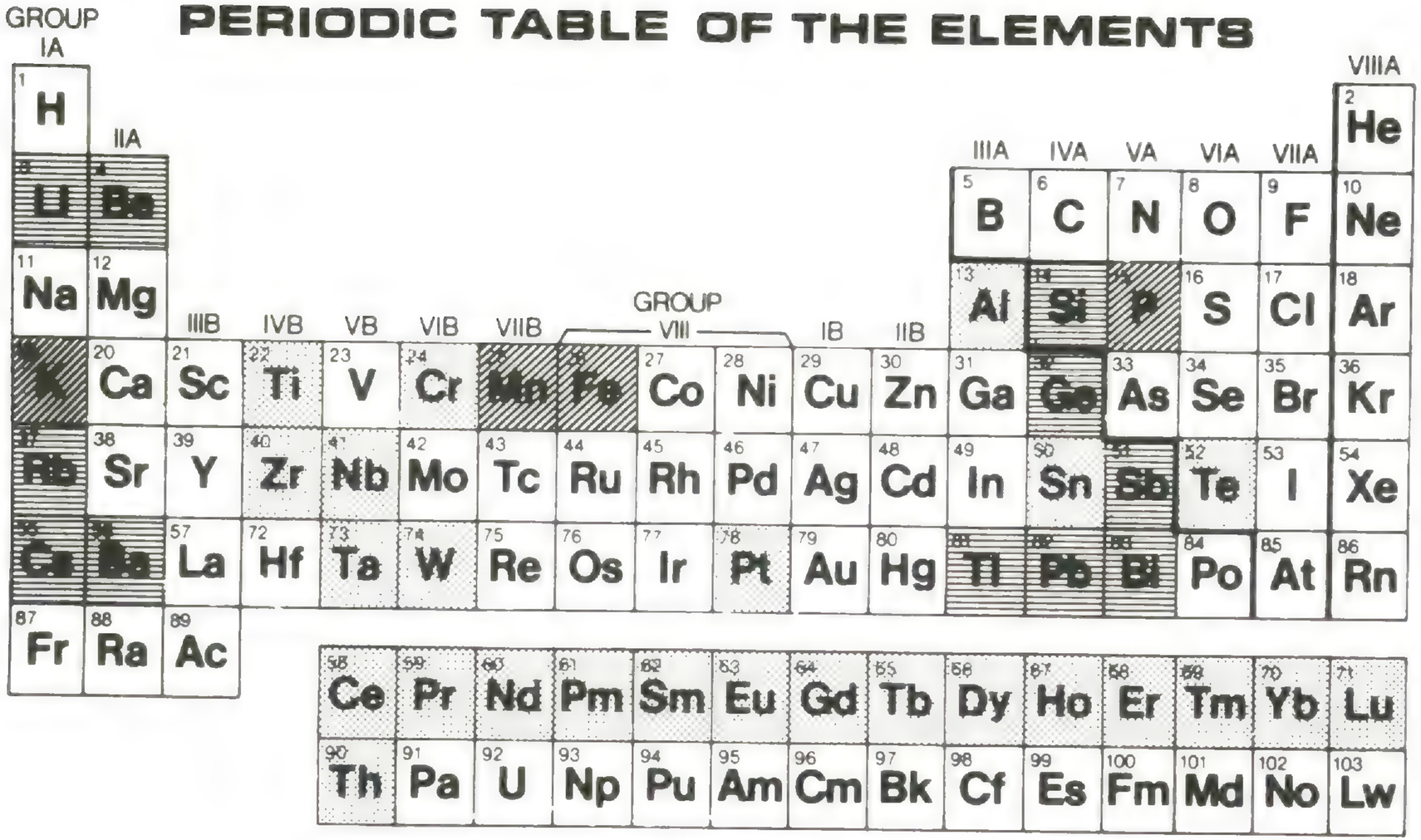

TABLE 1.

ELEMENTS WITH VERY LOW MOBILITY OR IMMOBILE: STIPPLED
ELEMENTS WITH LOW MOBILITY: BARRED
ELEMENTS WITH LOW MOBILITY WHICH ARE BIOGENIC: DIAGONALLY BARRED

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IBAPICHUNA: AN EDIBLE DACRYODES (BURSERACEAE) FROM THE NORTHWEST AMAZON

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It has recently been found that the fruits of *Dacryodes belemensis* Cuatr. (Burseraceae) are of use to the Kubeo Indians of the Colombian Vaupés. The fruits of this tree, known locally as "Ibapichuna," are employed to make a beverage. Utilization of this species came to light during recent field work in Colombia and Brazil (1979) while I was studying several apocynaceous genera which yield edible fruits. The principal observations were made during a short stay on the Río Kubiyú, an affluent of the Río Vaupés about 50 km. upriver from the town of Mitú (capital of the Comisaría del Vaupés), at approximately 1°03′ N. Lat., 70°16′ W. Long.[1] This part of the Colombian Amazonia is adjacent to the Brazilian State of Amazonas. Prior to the present century, this portion of the Vaupés, below the Raudal de Yurupari ("Devil's Cataract" —0°50′ N. Lat., 70°34′ W. Long.) on the Río Vaupés, was claimed by Brazil.

During my stay on the Río Kubiyú, the inhabitants prepared several fruits which supplemented the usual diet of tapioca (from *Manihot esculenta*), game, and fish. For the most part, these fruits included those of the palms *Jessenia Bataua* and either *Oenocarpus* or *Euterpe*. A fruit unfamiliar to me was collected which the natives know as "Ibapichuna." The name comes from Tupi-Guaraní (Lengoa Gêral or Nhengatú) meaning black fruit: iba-fruit; pichû-black (Ruiz, 1876). The fruits were similar in appearance to those of the palms, but they had a green resinous pulp covering a hard endocarp, rather than the pink-to-purple oily pulp characteristic of the palms. It was possible to

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[1] Previous studies in 1975 and 1976 were carried out in the same region, primarily on members of the Apocynaceae and other plants of economic interest.

gather specimens from a nearby tree which had been felled that very day for its ripe fruit. A duplicate of that collection *(Zarucchi 2487)* was sent to the Smithsonian Instititution, where it was determined as the second known collection of *Dacryodes belemensis* Cuatr.[2] Dr. José Cuatrecasas, who made the identification, has said that my voucher collection "coincides perfectly with the type specimen [*Pires s.n.* holotype US] in outlines, texture, size and color" (Cuatrecasas, pers. comm.). He also mentioned that the use of the fruits by indigenous peoples "indicates that the species is less rare than the scarcity of botanical specimens might suggest." Conversations with several botanists (R.E. Schultes, J. Cuatrecasas, and H. García-Barriga), familiar with the Río Kubiyú and/or adjacent areas of the Colombian Vaupés, have failed to turn up specimens or additional observations regarding the food use or occurrence of *Dacryodes.*

Dacryodes is a pantropical, dioecious member of the Burseraceae which was first described by Vahl in 1810, based upon a collection from Puerto Rico (Cuatrecasas, 1957; Lam, 1932). The majority of the species, as the genus is presently accepted, occur in Africa and Asia (sections *Pachylobus* and *Tenuipyrena*). The twenty neotropical species are assigned to the wholly American section *Dacryodes.* The most recent revision of this section by Cuatrecasas (1957) comprises fifteen species and two varieties; five additional species have been described since Cuatrecasas' publication (fide: *Gray Herbarium Cards*). Species of sect. *Dacryodes* are known from widespread areas in tropical America: from the Caribbean Islands to scattered localities in northern South America. Most species are known from only a few collections; some are represented solely by fruiting specimens.

My collection (*2487*) appears to represent the second one of *Dacryodes belemensis* and was found some 2450 km. from the type locality: "Brazil: Belém em terras do Inst. Agron. de Norte (Reserva de floresta nativa), Horto Mucambo, arvore no. *10–18,*

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[2] Specimens of *Zarucchi 2487* have been deposited in the herbarium of the Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá (COL); the Gray Herbarium of Harvard University (GH); and the United States National Herbarium (US). Additional duplicates will be distributed from COL and GH.

J. M. Pires (holotype, US)." No flowering material is yet available for this species. The voucher collection for this study was made on July 16, 1979, near the end of the rainy season. The specimens were collected from a tree 15 m. tall; the trunk was clear of branches for about two-thirds of its height. The tree has alternate imparipinnate (usually 2- to 3-jugate) compound leaves with axillary inflorescences. The mature fruits are oblong-ellipsoid, about 20-25 mm. long and 13 mm. in diameter.

Natives of the Río Kubiyú, with whom I spent several weeks, provided the following information regarding "Ibapichuna." It is a medium-sized tree of the forest understory, said to be relatively rare in mature forests, found growing on non-inundated sandy soil. Furthermore, it is reported that not all of the trees produce fruit, suggesting that the species is dioecious. The local inhabitants claim that it flowers in February or March.

The manner of fruit collection is destructive. Trees are felled, and all of the mature fruits (deep violet to black) are gathered and carried back to the habitation in a woven palm leaf basket. The trees that are felled are visited repeatedly over several weeks as additional fruits become mature.[3] A normal tree yields 3 to 4 kg. of fruit in the initial gathering. No use is made of the wood, but it was pointed out that the trees produce a resin which can be used for torches. After the fruits are washed thoroughly, they are put into a large vessel, covered with water, and placed over a fire to heat slowly to near the boiling point; this takes approximately 30 minutes. The fruits can now be eaten, but they are usually crushed and extracted to prepare an after-dinner beverage. To make this drink, the warm fruits are placed upon a loosely woven sieve basket, with an appropriate container below to catch the extracted pulp. The fruits are then crushed by hand, and warm water is repeatedly added to the mass of pericarp, pulp, and bony endocarp to extract the green pulp. The kneading process continues until most of the pulp has passed through the sieve. The resulting liquid is a resinous, bright green beverage with an appearance similar to thin spinach purée.

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[3] This repeated gathering of fruits from a felled tree has previously been observed by the author in the case of *Couma macrocarpa* Barb. Rodr. (Apocynaceae), known in the Colombian Amazon as "Juansoco" and as "Sorva" in Brazil.

I found the drink difficult to imbibe. My informant, Sr. Miguel Triana, stated that not everyone partakes of the beverage; the resinous quality is not universally enjoyed. The heated fruits are more palatable, although they have a sharp, tangy taste. The fruit is crushed between the tongue and the roof of the mouth, and the creamy-smooth, slightly fibrous pulp is extracted by the tongue from between the crisp exocarp and the bony endocarp. These latter parts are then expelled from the mouth. Much practice is necessary to accomplish this maneuver with ease.

A collection by Cardona (*Cardona 2364—Dacryodes peruviana* var.*caroniensis*) reports that the fruits are eaten by the Arekuna Indians of Venezuela: ". . . arbol 30 m. cuyo fruto llamado 'urá' es comido por los Arekunas" (Cuatrecasas, 1957). Lam (1932), in his study of the Burseraceae for southeast Asia, mentions in the discussion of *Dacryodes rostrata* that "the fruits are said to be very bitter to the taste, although a Luzon specimen mentions that they are eatable." Uphof (1968) states that *Dacryodes edulis* from tropical West Africa has edible fruits that are consumed by the natives. Additional uses of *Dacryodes* described by Uphof include the utilization of woods in construction and the extraction of resins. In 1965, Sandwith described *Dacryodes trinitensis* from Trinidad. This species which he compared with *Dacryodes excelsa* (a widespread West Indian species) and *Dacryodes belemensis*, was observed by Dr. D. W. Snow as being one of the most important sources of food for the Oilbird (*Steatornis caripensis*). A discussion of the fruits and their food value, as well as the role that the Oilbirds might play in the dispersal of the *Dacryodes* fruits is presented by Sandwith (1965).

The observation of the role of *Dacryodes belemensis* as a food source therefore complements previous studies of other members of the genus and suggests directions for future study of this little-known tropical species.

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RUIZ AS AN ETHNOPHARMACOLOGIST IN PERU AND CHILE

RICHARD EVANS SCHULTES

One of the regrettable situations in modern botanical research is the frequent lack of interest on the part of systematists and floristic specialists in native uses of plants. This neglect, sometimes even disdain, of indigenous knowledge and utilization of plants appears to be on the increase at a time when much of the world's native lore hovers on the verge of extinction.

Field botanists of periods past usually gave more attention to the relationship of peoples in primitive societies to their ambient vegetation. Yet even these earlier investigators were often so engrossed in the study of the general flora that they passed up opportunities of outstanding potentialities in tapping native understanding of the properties of plants.

Don Hipólito Ruiz, the Spanish botanist who directed a plant collecting expedition to Peru and Chile from 1777 to 1788, represents a notable exception to the rule. Ruiz is commonly regarded — and quite correctly so — as a systematic and floristic botanist, yet his writings indicate that he should be considered also as a major ethnobotanist of his period.

Ruiz was deeply interested in the uses of plants and in classification of economic plants. He devoted special attention to Cinchona, source of quinine, and wrote extensively on this genus. He published monographic studies on specific native medicinal plants. Indigenous use of plants is often noted in his descriptions of new species. The various published works of Ruiz and his colleague, Don José Pavón, contain many references to native uses of the plants of Peru and Chile. This is true especially of their *Systema Vegetabilium Florae Peruvianae et Chilesis* (1798) and their *Flora Peruviana et Chilensis* (1798–1802).

It is, however, in Ruiz' *Relación Histórica del Viage que Hizo a los Reynos del Perú y Chile el Botánico Hipólito Ruiz en el Año de 1777 hasta el de 1788* ..., a kind of diary, that one finds the

greatest wealth of ethnobotanical data. With the exception of an ethnobotanical index in the Jaramillo Spanish edition of the *Relación* (see below), these original notes apparently have not hitherto been gathered together for publication.

In 1940, the Field Museum of Natural History published an English translation of the Spanish edition of Ruiz' *Relación* published by Padre Agustín Jesús Barreiro in 1931. This edi tion represents only a part of the *Relación*.

During the Second World War, whilst he was serving as Colombian Ambassador to the Court of St. James, the late Dr. Jaime Jaramillo Arango discovered in the British Museum (Natural History) the manuscript of the entire *Relación* of Ruiz. This complete document was edited by Dr. Jaramillo and elegantly published in Spain in 1952. At the request of Dr. Jaramillo, I translated the Spanish text into English with his wife, Doña María José de Jaramillo. Our translation is now ready for publication. It is from this original and complete edition that the following notes on the ethnopharmacological uses of Peruvian and Chilean plants have been culled.

In view of the current interest in biodynamic plants, I have decided in this paper to report only those uses that depend apparently on the presence of active secondary organic chemical constituents: medicines, poisons, perfumes, dyes, etc. The *Relación* contains many other ethnobotanical references to plants valued in construction, as foods, as sources of wood, as material for clothing and for other purposes — uses obviously based on the carbohydrates, proteins and fats and oils content of the plants.

Ruiz' ethnobotanical reports should be unusually significant and important to modern students. They are the result of direct observation in the field; they were gathered by a botanist and are based on voucher specimens; they outline plant uses of two hundred years ago by natives in a relatively primitive society which has long since passed from existence.

It has seemed most useful to present the following data under the plant name used by Ruiz in his *Relación*. I have found that an appreciable number of the Latin binomials have apparently never been validly published. However, since they have all appeared in Jaramillo's Spanish edition of the *Relación* and since

some were published in Barreiro's earlier incomplete edition, they may be considered as *nomina nuda.* Amongst the names used in the *Relación,* a few are synonyms; it has been possible in some cases to indicate in brackets under the original binomial the currently accepted name.

The genera are arranged alphabetically under families. The families are enumerated in accord with the system of Engler and Prantl.

Polypodiaceae

Polypodium Incapcocam *nom. nud.*
(cucacuca; incapcocam; coca del Inca)

According to the Indians, the Incas used the leaf in place of real coca. In the form of a powder, it was taken instead of tobacco "to clear the head."

Pteridaceae

Achrostichum Cuacsaro Bert. Opusc. Sci. Bol. 1 (1817) 241, t.8.
(cuacsaro)

The roots are sold commercially as genuine calaguala (Polypodium sp.), but they lack the medicinal virtues.

Araucariaceae

Pinus chilensis *nom. nud.*
[*Araucaria araucana* (Mcl.) C. Koch Dendrol. 2, ii (1873) 206.]
(pino de Chile)

When the natives engaged in felling this tree gash themselves severely, they apply the resin of the tree to the wound. "There is no doubt that it produces the effect that they want. It is also found to be very helpful as a calmative in cases of ruptures and bruises."

Araceae

Calla nuda *nom. nud.*

The root is thought to have properties making it effective in the treatment of snake bites.

Bromeliaceae

Pourretia coarctata R. et P. Fl. Peruv. 3 (1802) 34.
[*Puya chilensis* Mol. Sagg. Chil. (1782) 160, 351.]
(cardón; puya)

An excellent extract for setting fractures is got from the raceme or long stalk of the inflorescence of this plant. The nectar of the flowers is fragrant and tasty; when applied to an aching ear, it is said to lessen the pain and to cure the ailment.

Tillandsia usneoides L. Sp. Pl., Ed. 2 (1762) 411.
(salvagina, saccropa, millmahina, cotataura)

In warm baths, this plant is valued as an antinervine to rebuild physical strength and to aid in inducing sleep. The Indians fill mattresses with it to repell flies. It is likewise appreciably valued by those with back–ache and kidney trouble. Crushed and mixed with fat, it is applied to treat hemorrhoids.

SMILACACEAE

Smilax China L. Sp. Pl. (1753) 1029.
(purampsii)

An infusion of the roots is frequently used by the Indians to relieve rheumatic pains and as an excellent sudorific. Ruiz published more extensively on native uses of this plant in his *Memoria sobre la Raiz de China,* Real Academia Médica de Madrid, vol. 1 (1797).

AMARYLLIDACEAE

Agave americana L. Sp. Pl. (1753) 323.
(pita; ancaschampascera; maguey mexicana)

The Indians employ an infusion and decoction of the roots to cure rheumatic and venereal pains. It is drunk in large quantities. The leaves yield a "honey" or extract which is believed to be excellent for cleansing and healing ulcers. The leaves are roasted, and the juice is squeezed out whilst they are still hot. The extract is then boiled down to the thickness of soft honey, in which state it is applied with no other agent to cure not only ulcers in man but also sores on beasts of burden and the wounds which they often suffer on the head and feet.

Alstroemia Ligtu L. Sp. Pl., Ed. 2 (1762) 462.
(liutu)

The Chileans extract a white starch from the roots which provides a soft food for babies and the elderly and those suffering from stomach ailments. This flour is very easily digested.

Polianthes tuberosa L. Sp. Pl. (1753) 316.
(Cited in the *Relación* as *Polyanthes tuberosa.*)
(margaritas blancas; vara de Jesse)

Emollient plasters are prepared from the roots.

IRIDACEAE

Sisyrinchium anceps Cav. Diss. 6 (1788) 345, t.190, fig. 2.
S. Ocsapurga *nom. nud.*
(palma-palma; pajapurgante)

A decoction of the roots is laxative. A slight tasting of these roots leaves a pungency and acrimony in the mouth for more than six hours and may cause much discomfort. "I judge from this that its purgative properties are too drastic and ought to be used more cautiously than the Indians are wont to do."

Sisyrinchium luteum Bert. ex Steud. Nom., Ed. 2 (1841) 596.
[*Sisyrinchium tinctorium* HBK. Nov. Gen. et Sp. 1 (1816) 324.]

Sysyrinchium convolutum Nocca Pl. Select. Ticin. (1800) 128, t.1.

Sisyrinchium purgans *nom. nud.*
(ossapurga; pajapurgante)

The natives employ the roots as a purgative, controlling the strong laxative effects with draughts of cold water. Since it is a potent laxative, it must be used with caution.

Sisyrinchium multiflorum Steud. Nom., Ed. 2, 2. (1841) 596.
[*Orthrosanthus multiflorus* (Steud.) Sweet Fl. Austr. (1827–1828) t.11.]
(tekel; huilmo blanco)

The Chilean natives use this plant as a strong laxative, making an infusion of the roots in water.

Sisyrinchium quadriflorum *nom. nud.*
(huilmo)

A decoction or warm infusion of the roots is taken as a purgative and to expel "venereal humours."

ZINGIBERACEAE

Amomum racemosum R. et. P. Fl. Peruv. 1(1798) 2.
[*Renealmia Ruiziana* Horan. Prod. Scitam. (1862) 33.]
(achira de monte)

The seeds are "not less oily and useful for medicinal purposes than the seeds of *Amomum thyrsoideum,* which is plentiful..."

PIPERACEAE

Piper Carpunya R. et. P. Fl. Peruv. 1 (1798) 37, t. 63.
(carpunya)

The aromatic leaves become more fragrant when dried. The natives drink one or two cups of an infusion as an aid to digestion. They prefer it to real tea.

Piper dichotomum R. et P. Fl. Peruv. 1 (1798) 35, t. 60.
(Cited in the Relación as Piper dichotoma)

The leaves of this species can be used as a substitute for *P. Carpunya,* for they are almost equally as fragrant and tasty.

CHLORANTHACEAE

Tafalla glauca R. et. P. Syst. (1798) 271.
[*Hedyosmum glaucum* (R. et P.) Cordem. in Adansonia 3 (1863) 303.]
(aitacupi)

These bushes give off tears of resin, very similar in shape, colour, and smell to mastic, for which reason the plant is frequently called almaciga. The resin is used to alleviate headaches, applied to the temples as a plaster.

Tafalla triflora *nom. nud.*
(aitacupi)

The resin, called almaciga ("mastic"), is collected in some regions of Peru and used as a comforting plaster.

JUGLANDACEAE

Juglans nigra L. Sp. Pl. (1753) 997.
(nogal del país)

"Take equal parts of the native walnut, soot and colophony and boil them together with wool previously soaked in alum solution. The resulting dye is resin–colour."

MYRICACEAE

Myrica stornatatoria *nom. nud.*
(ssayre; tuppassayre; laurel)

The entire shrub is useful for dyeing leather black. The powdered bark causes repeated sneezing and is extensively used to clear the head and to relieve headaches.

Betulaceae

Betula nigra L. Sp. Pl. (1753) 982.
(ramra)

The bark soaked in urine gives colour to sole leather; it can also dye cottons and woollens a cinnamon hue. The bark serves also as a tannin. Pounded up and mixed with lard, the leaves are applied as a poultice to cleanse and heal ulcers. Without lard, they are valued in treating inflammations. When applied to fresh wounds, they staunch the flow of blood.

Fagaceae

Fagus oblongifolia *nom. nud.*
(pellín)

Chileans employ the bark to dye woollens a dark purple.

Fagus Pellin *nom. nud.*
(pellín)

Crushed up and mixed with lime or bran, the bark is employed as a tanning material, dyeing sole leather a red colour.

Urticaceae

Urtica spiralis Domb. ex Wedd. in Ann. ser. 3, 18 (1852) 232.

A gum resembling gum arabic weeps from the wounds inflicted on the branches. The yield is small.

Proteaceae

Embothrium dentatum R. et. P. Fl. Peruv. 1 (1798) 62, t. 94.
(raral)

The bark and leaves are the source of a black dye.

Embothrium emarginatum R. et P. Fl. Peruv. 1 (1798) 62.
[*Embothrium grandiflorum* Lam. Encycl. 2 (1786) 354.] t. 95.
(catas; machinparrani)

The leaves are crushed and applied to contusions by the Indians; powdered, they are said to dry up ulcers and help the growth of new flesh.

Embothrium monospermum R. et P. Fl. Peruv. 1 (1798) 63, t. 98.
[*Roupala monosperma* (R. et P.) I. M. Johnston in Contrib. Gray Herb. 73 (1924) 42.]

Embothrium pinnatum R. et P. Fl. Peruv. 1 (1798) 63, t. 97. [*Roupala pinnata* (R. et P.) Diels ex Macbride in Field Mus. Publ. Bot. 13, pt. 2, no. 2 (1937) 374.]
(catas; picahuai)

According to native belief, a powder prepared from the leaves of these two species, when applied to ulcers, hastens healing and the growth of clean new flesh.

LORANTHACEAE

Loranthus semicalyculatus *nom. nud.*

Loranthus verticillatus R. et P. Fl. Peruv. 3 (1802) 47. [*Phrygilanthus verticillatus* (R. et P.) Eichl. in Martius Fl. Bras. 5, pt. 2 (1868) 47.]
(ictricgo; michtrin; quintral)

Both species yield a black dye.

ARISTOLOCHIACEAE

Aristolochia fragrans *nom. nud.*
[This name may represent the same species-concept as *Aristolochia fragrantissima* Ruiz in Mem. Virt. Bejuco Estrella (1805) 46.]
(bejuco de la estrella; contrayerba)

The Cholone Indians use the root to cure rheumatic and venereal pains, drinking a decoction of it at night. "A few hours after taking such a draught, the patient breaks out in a profuse sweat that continues for three days. On the fourth day, he is fully recovered and can leave his sick bed without any ill effects to hinder his work. I have used this root in Peru for killing toothache, upon the recommendation of Father Francisco González Laguna. One might expect that in time this root will find an important use in medicine, for its aroma and taste bespeak excellent properties, making it valuable for a number of therapeutic applications, surpassing those of *Serpentaria virginiana.*"

POLYGONACEAE

Coccoloba carinata Ruiz ex Meissn. in DC. Prodr. 14 (1856) 150. [*Muehlenbeckia tamnifolia* (HBK.) Meissn. Comm. 2 (1840) 227.]

Coccoloba nitida HBK. Nov. Gen. et Sp. 2 (1817) 176.
(muyaca)

The Indians consider this shrub to be an excellent diuretic for ailments of the urinary tract.

Rumex Patentia L. Sp. Pl. (1753) 333.
(hualtata)

The purplish leaves are used in Chile as a supperative agent, whereas the green leaves are employed as a resolutive. Both kinds of leaves, applied to the back, "reduce the heat of the blood."

Chenopodiaceae

Chenopodium amarum *nom. nud.*
C. dulce *nom. nud.*
(payco)

A warm infusion is considered in Chile to be an excellent digestive and is used in place of tea.

Amaranthaceae

Achyranthes obovata Pav. ex Moq. in DC. Prodr. 13, pt. 2. (1849) 359.
[*Alternanthera Achyrantha* R. Br. Prodr. 1 (1810) 417.]

Achyranthes rigida *nom. nud.*
(yerba del moro hembra and yerba del moro macho, respectively)

Both specimens are employed in decoction to lessen bleeding. Crushed with salt, they are applied to lessen bloody hemorrhages and heal ulcers; the poultice is changed every 24 hours. The natives heal bruises and cuts of the feet caused by the calyces of these species that enter as splinters when shoes are not worn.

Celosia conferta *nom. nud.*
(yerba de la sangre)

The juice and a decoction of its tuberous root are considered to be hemostatic — whence the vernacular name.

Portulaccaceae

Talinum monandrum R. et P. Syst. (1798) 118.
Talinum nitidum R. et P. Syst. (1798) 117.
Talinum umbellatum R. et P. Syst. (1798) 117.
(yerba de la mistela)

The flowers impart a crimson colour to mistela (a liquid made of urine, sugar and cinnamon). The country women tint their

cheeks with the juice of this herb, and it gives them a "bright and attractive blush."

NYCTAGINACEAE

Boerhaavia scandens L. Sp. Pl. (1753) 3.
(yerba de la purgación)

The infusion or decoction is thought to be effective against gonorrhoea.

Neea verticillata R. et P. Syst. (1798) 90.

The fruits are used by Indians to stain feet, hands and face purple; they are also a source of a dye for cotton.

PHYTOLACCACEAE

Phytolacca icosandra L. Sp. Pl. (1753) 631.

The Indian women value the ripe fruits to make a dye for cotton.

AIZOACEAE

Sesuvium Portulacastrum L. Syst. Ed. 10 (1759) 1058.
(litho)

In Ica and other parts of Peru, the aborigines collect this species of glasswort for use in manufacturing glass and soap.

BASELLACEAE

Chenopodium tuberosum *nom. nud.*
[*Ullucus tuberosus* Lozano in Caldas Sem. Nueva Granada (1809) 185.]
(ulluco)

The roots are a common carbohydrate food. An infusion of the whole plant is taken as an expectorant and aid in childbirth.

BERBERIDACEAE

Berberis lutea R. et P. Fl. Peruv. 3 (1802) 51, t. 280.
(ccarhuascassa; palo amarillo)

Indian women utilize the wood of this species to dye their cottons and course textiles a beautiful and fast canary yellow.

Berberis mucronata *nom. nud.*
Berberis tortuosa Domb. ex DC. Syst. 2 (1821) 11, in *syn.*
[*B. flexuosa* R. et P. Fl. Peruv. 3 (1802) 52, t. 281.]

The wood yields an excellent yellow dye.

Monimiaceae

Pavonia sempervirens R. et P. Syst. (1798) 253.
[*Laurelia sempervirens* (R. et P.) Tul. in Arch. Mus. Paris 8 (1855–56) 416.]
(laurel de Chile)

Warm baths of this plant are believed to "strengthen the nerves" and, because of this virtue, the plant is used in treating convulsions, paralysis and rheumatic spasms. When drunk at each meal time, an infusion of the leaves is said to calm rheumatic pains.

Gomortegaceae

Gomortega nitida R. et P. Syst. (1798) 108.
[*Gomortega Keule* (Mol.) I. M. Johnston in Contrib. Gray Herb., n.s. no. 70 (1924) 92.]
(keule)

The leaves have an acid–astringent taste and stick to the teeth when they are chewed because of their resin content. If crushed between the fingers, they give off a fragrance suggestive of rosemary and spirits of turpentine; judging from its aromatic qualities, we might infer that the plant possesses healing properties. "The beautiful fruits are as large as small hen's eggs and are lustrous, of a yellow colour that invites one to eat them. When eaten in excess, however, they bring on headaches."

Lauraceae

Laurus fragrans Salisb. Prodr. (1796) 344.
[*Lindera Bensoin* Meissn. in DC. Prodr. 15 (1864) 244.]
(mucamuca)

The seeds are aromatic and have stomachic properties.

Laurus Peumo Domb. ex Lam. Encycl. 3 (1789) 455.
(peumo)

The bark has astringent properties and yields an orange–coloured dye for leathers. The Chileans assert that the fruits possess virtues valuable in treating dropsy.

Ruizia fragrans R. et. P. Syst. (1798) 267.
[*Peumus Boldus* Mol. Sagg. Chil. (1782) 185.]
(boldu; boldo)

Chileans employ the crushed leaves extensively "to strengthen the stomach" and relieve pains. They cure earaches with the sap of the leaves extracted with water. To treat running sores and colds in the head, they apply the leaves, half roasted, bruised and sprayed with wine. Warm baths prepared with the leaves are taken as unsurpassed cures for rheumatism and dropsy. An infusion of the leaves can be taken daily in place of tea.

PAPAVERACEAE

Bocconia frutescens L. Sp. Pl. (1753) 505.
(palo amarillo)

This vernacular name refers to the colour of the sap, which can be employed to dye cottons, woollens and course hempen cloth yellow.

CRUCIFERAE

Lepidium foetidum *nom. nud.*
[This name may refer to the species-concept *Coronopus didymus* (L.) Smith Fl. Brit. 2 (1800–1804) 691.]
(chichiccara; huanuccara; mastuerzo silvestre)

Frequently, this herb is used to cure "valley sickness." The plant is rubbed vigourously in water which is then administered as an enema. Crushed and slightly warm, it is poulticed to cleanse and cure cancerous ulcers. Crushed and mixed with lard, it is applied to the abdomen to relieve swelling brought on by retarded menstruation.

Sisymbrium Sophia Barnh. in C. Gay Fl. Chil. I (1845) 127.
(Cited in the *Relación* as *Sisymbrium sophiae.*)
(ucuspatallan)

In the Provinces of Tarma and Huamalíes, this plant is used as a diuretic. Some believe it to be a stronger diuretic than it is, "for they prepare the infusion with the dried plant, in which state it lacks ammonium and is, therefore, nearly inert."

CRASSULACEAE

Sedum Ccallu *nom. nud.*
(ccallu)

The juice is used to dissolve films and the beginnings of cataracts of the eyes.

Saxifragaceae

Stereoxylon resinosum R. et P. Prodr. (1794) 14, t. 6.
[*Escallonia resinosa* (R. et P.) Pers. Syn. 1 (1805) 235.]
(tiri encarnado; puca tiri; chachacoma)

The women esteem the tips of the branchlets to prepare a purple and red dye.

Rosaceae

Acaena anserinaefolia *nom. nud.*

This plant is used to treat gonorrhoea, the infusion or decoction being drunk in the morning and afternoon.

Acaena pinnatifida R. et P. Syst. (1798) 413.

This plant is reputedly an excellent diuretic and refrigerant.

Geum urbanum L. Sp. Pl. (1753) 501.
(quellgón; canelilla)

The epithet canelilla ("little cinnamon") alludes to the aroma of the roots, which are used in infusion or decoction as an apperative and resolutive. Some people keep pieces of the root in the mouth to counteract the unpleasant smell often engendered by decaying teeth.

Kageneckia lanceolata R. et P. Syst. (1798) 290.

The bark and leaves are bitter and are employed in infusion for treating fevers.

Kageneckia oblonga R. et P. Syst. (1798) 289.
(guayo colorado)

The bark is employed in tanning skins, and the natives in Chile value the seeds as a purgative.

Nespilus uniflora C. Kock in Wochenschr. 5 (1862) 383.

An infusion is considered a cure for the sickness known as verrugas (Carrion's disease).

Smegmadermas emarginata R. et P. Syst. (1798) 288.
[*Quillaja Saponaria* Mol. Sagg. Chile (1802) 175, 354.]
(quilley)

A decoction of the bark is applied in clysters for treating hysterics.

Astragalus canescens Bunge, Astrag. 2 (1879) 174.
(garbancillo)

When eaten in excess, this legume causes severe pains and constant trembling in animals. It may lead to death.

Caesalpinia Tara R. et P. Fl. Peruv. 4 (1802) t. 374.
[*Caesalpinia spinosa* (Mol.) Kuntze Rev. Gen. 3, pt. 2 (1898) 54.]
(tara)

Sticks of tara are split up finely; urine is poured over the pieces of wood, which are then set out in the sun. Urine is repeatedly poured over them, until they are well soaked. After airing, the sticks are boiled in water, together with red tiri (*Stereoxylon resinosum*) and woollen or cotton fabrics. The dye is a purplish red.

The dried fruit of tara and a bit of soot are boiled together with woollens soaked in iron sulphate or vitriol without acid. The fabric will be dyed a beautiful clove–colour.

Cassia mimosoides L. Sp. Pl. (1753) 379.
(huaranhillo)
[This vernacular name applies to *Cassia glandulosa* L. Sp. Pl. (1753) 542.]

Cassia Tora L. Sp. Pl. (1753) 376.

An infusion of the leaves of both species acts as a purgative.

Cassia procera *nom. nud.*
(cañafistula)

The bittersweet pulp of the pod is taken as a laxative by Peruvian Indians.

Cassia reflexa Salisb. Prodr. (1796) 326.
(mayo; mayu)

The bark yields a yellow dyestuff.

Cassia setacea *nom. nud.*

Cassia undecimjuga *nom. nud.*
(pachapacte; hatumpacte)

The natives use the leaves in infusion as a purgative.

Indigofera Anil L. Mant. 2 (1771) 272.
(añil)

Indigo for ink and paint is extracted from this plant in Peru.

Mimosa *sp.*
(espina)

In Chile, the rind of the pod is used to make a black ink.

Mimosa punctata L. Syst. Ed. 10 (1759) 1311.
(tapateputilla)

A powder made of the leaves is esteemed in Lurin as the best remedy for healing ulcers.

Myroxylon peruiferum L. f. Suppl. (1781) 233.
(quinoquino)

A pomade of the fruits prepared in powder form together with the bark mixed with tallow or resins is applied as a poultice to reduce headaches. The crushed fresh leaves are said to heal new wounds; the same properties are claimed for the resin and the bark, for both are renowned as admirable balsamic and vulnerary agents. An oil called quinaquina is prepared from the fruits. A balm, reputedly very effective for ulcers of the chest, is prepared from four ounces of the fruit bruised and infused in a pint of wine for twenty-four hours; this is then cooked over a slow heat with a pound and a half of ordinary oil, until it is dry. Then one pound of turpentine and one ounce and a half of incense and an equal amount of myrrh are added. This preparation is said to agglutinate and heal open sores.

Negretia elliptica R. et P. Syst. (1798) 176.
[*Mucuna elliptica* (R. et P.) DC. Prodr. 2 (1825) 405.]

Negretia inflexa R. et P. Syst. (1798) 176.
[*Mucuna inflexa* (R. et P.) DC. Prodr. 2 (1825) 405.]
(llamapanaui)

The seeds are believed to be antidotal to the stings of small insects. They are taken in the form of a powder in two doses, and the powder is dusted over the bites of the toxic animal.

Negretia spinosa *nom. nud.*
[This name refers probably to the species concept *Mucuna elliptica* (R. et P.) DC. Prodr. 2 (1825) 405.]
(llamapanaui)

The Indians consider the seed an effective antidote for snake bites and insect stings. It is powdered and applied directly to the bite, and about one drachma of the seed swollen in water is taken

internally. Some take half a scruple of the prickles or bristles in a cup of chocolate, milk or sugared water as an anthelmintic.

Psoralea capitata L. f. Suppl. (1781) 339.
(yerba de San Agustín; yerba de la Trinidad, yerba del Carnera, huallicaya)

The natives often utilize the leaves to cleanse ulcers of pus and to aid in regeneration of flesh; later, leaves of the same plant are applied in powdered form to hasten healing.

KRAMERIACEAE

Krameria triandra R. et P. Fl. Peruv. 4 (1803) 61, t. 93.
(ratanhia; pumacuchu; mapato)

The roots have excellent styptic properties that can staunch the flow of blood, according to native belief. The dose for a decoction is half an ounce of dry root or one drachma of its water extract weakened with two or three ounces of ordinary water. This root is good for "cleansing and strengthening the teeth." According to Ruiz, the root "surpasses in efficiency all other herbs which are employed at the present time to staunch the flow of blood and lacks the evil after effects that other astringents cause. Experiments with more than one thousand persons who have taken the extract under the care of the best physicians bear out the statement."

Ruiz published more extensively on the styptic uses of this plant in his *Memoria sobre la Ratanhia* in Memoirs of the Medical Academy of Madrid, vol. 1 (1797).

OXALIDACEAE

Oxalis Ockas *nom. nud.*
[*Oxalis tuberosa* Mol. Sagg. Chile 3 (1782) 109.]
(chullco–chullco; occas)

The stems and leaves are called chullco ("sorrel") and are said to be used "as a cooling agent in high fevers and typhoid," in treating painful urination, choking, sore throat and jaundice. The roots are crushed and applied as a cataplasm to reduce the swelling of goitre and mumps.

TROPAEOLACEAE

Tropaeolum majus L. Sp. Pl. (1753) 345.
(masteurzo; capuchinas)

The Peruvian natives frequently employ this plant to treat scurvy and mouth sores.

LINACEAE

Linum confertum *nom. nud.*
(merulaguén)

An infusion and decoction are frequently prescribed in treating catarrhal coughs and lung ailments. When crushed and mixed with urine, the plant can be applied as a poultice to dissolve various kinds of tumours.

MELIACEAE

Guarea purpurea C. DC. in DC. Monogr. Phan. 1 (1878) 564.
(cheñor)

Indian women in Peru dye their cotton goods and baize a purplish hue with this plant.

MALPIGHIACEAE

Malpighia nitida Jacq. Enum. (1760) 21.
[*Bunchosia nitida* (Jacq.) Juss. in Ann. Mus. Par. 18 (1811) 481.]
(ciruela del pais; ciruela del fraile)

The seeds, in flavour rather like fresh almonds, have purgative properties and bring on nausea.

POLYGALACEAE

Polygala aff. **discolor** *nom. nud.*
(mascca)

Indian women use the bark of the root to prepare a wash to cleanse and stimulate hair. Intensely bitter, the bark forms a lather like that of soap.

Polygala vulgaris L. Sp. Pl. (1753) 702.
(clinclín)

In Chile, a warm infusion of this plant is valued as an excellent diuretic.

Monnina polystachya R. et P. Syst. (1798) 171.

According to Ruiz, the bark has been shown to be effective in treating dysentery and asthmatic ailments. Three grains of its powder are taken in the morning and evening at the beginning of the treatment, and the dose continues to increase for several months.

Monnina salicifolia R. et P. Syst. (1798) 172.
(hacchiquies; pahuata-huinac, which means "growing at night")

Women prepare from this plant a hair wash and believe that it stimulates exuberant growth of the hair. The saponaceous constituents free the scalp from dandruff and the hair from oils. The roots are very bitter and have a much higher saponine content that the rest of the plant. "Excellent medicinal virtues, especially for treating dysenteries, reside in these roots, which have virtues not inferior to those of simarouba or *Quassia divica* or even those of *Quassia Amara.*"

EUPHORBIACEAE

Croton ciliatum *nom. nud.*
(huanarpo macho; higos del duende)

The natives assert that an infusion of the root of this milky plant is a strong aphrodisiac. They also claim that an infusion of the huanarpo hembra is its antidote. There is no difference between these two plants, except that the former has red flowers, the latter white ones.

Croton gummiferus A. Cunn. ex Pl. in Hooker, Lond. Journ. Bot. 4 (1845) 473.
(Cited in the *Relación* as *Croton gummiferum.)*
(sangre de drago)

"The taste, colour and astringency of the gum-resin are such as would recommend its use in medicine."

Jatropha aphrodisiaca *nom. nud.*
[This plant is probably *Jatropha ciliata* Muell.-Arg. in Linnaea 34 (1865) 209.]
(simayuca)

The Indians believe that the root has aphriodisiac properties.

Euphorbia Peplus L. Sp. Pl. (1753) 455.
[Cited in the *Relación* as "*Euphorbia Peplis?* Linn.?"]
(yerba de la golondrina)

The latex is used in the belief that it cures cataracts of the eye.

Euphorbia tuberosa L. Sp. Pl. (1753) 456.
[The plant is probably *Euphorbia Huanchahana* (Kl. et Gke.) Boiss. in DC. Prodr. 15, pt. 2 (1862) 103.]
(huachanccana)

The Indians take the root to Lima to sell as a purgative, but it must be used cautiously because of its drastic properties. Although the effects can be strong, the natives moderate its action simply by drinking one glass of cold water.

Euphorbia tricuspidata Lapeyr. Hist. Abr. Pl. Pyr. 1 (1818) 271.
Euphorbia portulacoides L. Sp. Pl. (1753) 456.
[*Euphorbia chilensis* Gay Fl. Chile 5 (1849) 335.]
(pichoa)

The Chilean natives take an infusion as a laxative. The drastic purging can be held in check by drinking cold water.

Ricinus communis L. Sp. Pl. (1753) 1007.
Ricinus ruber *nom. nud.*
(higuerella del pais; higuerilla mexicana, respectively)

The natives employ these plants as a superative for external swellings.

Sapium fragrans *nom. nud.*
(collihuay)

When the roots are burned, they give off a fragrance which is pleasant but which causes headaches. The milky latex is so caustic that it has caused woodcutters the loss of their sight.

Coriariaceae

Coriaria nervosa *nom. nud.*
[*C. ruscifolia* L. Sp. Pl. (1753) 1037.]
(deu)

The whole plant serves as a good tanning material.

Coriaria pinnata *nom. nud.*

Indian women utilize the fruits to dye woollens and cottons a bright purple.

Anacardiaceae

Rhus atrum *nom. nud.*

The sap in the bark and stems yields an ink as lustrous and black as printer's ink. It is weak in colour when freshly written but becomes blacker upon drying.

Schinus aurantiodora Ruiz ex Endl. in DC. Monogr. Phan. 4 (1883) 326.

Schinus oblongifolia *nom. nud.*
(mayco)

The shade of both species causes a stinging and painful rash that develops into infected sores accompanied by fevers. The Indians maintain that the shade of the latter species is more harmful that that of the former.

Schinus dependens Orteg. Hort. matr. Dec. (1798) 102.
(huighan; huighnan)

The trunk exudes a resin which, applied to the temples and behind the ears, lessens toothache and pains in the chest. Chileans prepare from the fruit an excellent chicha with diuretic properties which is thought to be effective against dropsy. "Recently, three persons in Concepción have been cured of dropsy by frequent use of this chicha." Even though the drink is not agreeable, the Indians take it at all meals. Its taste and smell suggest black pepper.

Schinus frondosus *nom. nud.*
(lithre; lithi)

The shade of this tree is so harmful that many people find that purulent sores are produced after they rest under the branches. These sores are accompanied by a high fever and attack expecially those parts of the body which have been exposed. Smoke from the burning wood and the vapours given off when woodchoppers fell it are equally noxious.

The antidote is maytén (*Celastrus* sp.). Maize grains masticated and applied to the sores likewise act as a cure.

Schinus Molle L. Sp. Pl. (1753) 380.
(molle)

One treatment for dropsy and gout consists of a bath of a salty infusion of the leaves and bark of molle. The Indians employ a fermented drink of the fruits in treating dropsy. The white, fragrant resin from molle is an excellent bone-set if applied in the form of a plaster, and it can be used to heal ulcers.

Schinus procerus (HBK.) March. Rev. Anacard. (1869) 164.
(Cited in the *Relación* as *Schinus procera*)
[*Cyrtocarpa procera* HBK. Nov. Gen. et Sp. 7 (1825) 20, t. 609.]
(molle de Chile)

When applied to the temples, the resin is said to alleviate headaches.

Celastraceae

Celastrus dependens *nom. nud.*
(maytén; magthun)

This showy bush is considered a remedy for the affection produced by lithre (a species of **Schinus**) which grows in the same region as maytén. "The Divine Wisdom surely put lithre and mayten together so that the ravages of the one could be cured by the antidotal action of the other." A poultice of the crushed leaves is applied to the purulent sores caused by the shade, smoke or effluvium of lithre and, at the same time, a purgative infusion of maytén leaves is imbibed.

Icacinaceae

Villaresia mucronata R. et P. Fl. Peruv. 3 (1802) 9, t. 231.
[*Villaresia emarginata* R. et P. Syst. (1798) 64.]
(huillipatagus)

The bark and fresh leaves have strong emetic properties and are taken in infusion to induce vomiting; in larger doses, the infusion acts as a purgative.

Sapindaceae

Dodonaea viscosa (L.) Jacq. Enum. (1790) 19.
(chamisa; chamana)

Crushed and applied as cataplasms on contusions, this plant has very fast and excellent healing properties, according to native informants.

Rhamnaceae

Rhamnus canescens *nom. nud.*
R. dependens *nom. nud.*
(trébol; trábul)

The bark is utilized in washing and cleansing the head. It is also substituted for calaguala as a resolutive and dissolutive agent in the treatment of blows.

Rhamnus verticillatus *nom. nud.*
(chacay)

In Chile, an infusion of the bark is valued in treating internal tumours and abscesses.

ELAOCARPACEAE

Aristotelia glandulosa R. et P. syst. (1798) 125.
[*Aristotelia Maqui* L'Herit. Stirp. Nov. (1784) 31, t. 16.]
(maque)

According to the natives, the fresh shoots, crushed and applied to the back and the area of the kidneys, lessen "excessive heat" in these parts of the body during fevers; when chewed, they cleanse and heal sores of the mouth.

MALVACEAE

Urena villosa *nom. nud.*
Urena hamata *nom. nud.*
(lausahacha)

Womenfolk wash their hair with the mucilaginous material extracted from these two plants with cold water. It is used to lessen dandruff, to cleanse the hair of excess oil and to stimulate growth.

OCHNACEAE

Sauvagesia ciliata *nom. nud.*
(yerba de San Martín)

The Indians employ this plant medicinally for many purposes, especially to treat fatigue and chest ailments.

Sauvagesia subtriflora *nom. nud.*
[This plant is probably *Sauvagesia erecta* L. Sp. Pl. (1753) 203.]
(yerba de San Martín)

The natives value a decoction in treating chest pains.

GUTTIFERAE

Clusia rosea Jacq. Enum. (1760) 34.

Clusia trioecia *nom. nud.*
(matapalo)

This strangler yields a resin, also called metapalo, which is highly esteemed in Peru for curing ruptures and fractures.

Clusia radicans Pav. ex Pl. et Tr. in Ann. Sc. Nat. ser. 4, 13 (1860) 374.
(pullapullquelpuan)

The resin is employed as a bone–set.

Hypericum sp.
(chinchanho)

Equal parts of yellow tiri *(Melastoma tomentosa)* and of chinchanho, a bit of alum and some wine are boiled together in water with cottons and woollens until the fabric is dyed yellow.

Hypericum corymbosum Muhl. ex Willd. Sp. Pl. 3 (1802) 1457.
(chinchanho)

These plants provide a yellow dye for woollens and cotton goods.

Hypericum subulatum *nom. nud.*
(chinchancco)

This plant is very abundant in Peru and is employed by the natives to dye woollens and cotton fabrics a beautiful yellow.

BIXACEAE

Bixa muricata *nom. nud.*
(maxpachín)

Peruvian natives colour their foods and dye a variety of objects with the seeds, as they do also with the seeds of *Bixa Orellana.*

Bixa Orellana L. sp. Pl. (1753) 512.
(achote; achiote; huantura)

The seeds are reputedly an excellent diuretic. They are used to colour spiced foods and serve also as a dyestuff.

LOASACEAE

Loasa punicea Phil. In An. Univ. Chile (1884) reimpr. 4.
(pomaysancca)

Women in rural areas take an infusion or decoction to induce menstruation.

LYTHRACEAE

Cuphea ciliata R. et P. syst. (1798) 120.
(yerba de la culebra)

The natives employ a decoction and infusion of this plant to relieve weariness and fatigue.

UMBELLIFERAE

Hydrocotyle umbellata L. Sp. Pl. (1753) 234.
Hydrocotyle vulgaris L. Sp. Pl. (1753) 234.
(oreja de abad, petacones)

The juices of both species are said to cure ulcers of the mouth. When applied to an infected pimple, they bring it to a head and heal it.

Myrtaceae

Psidium nitidum Wright in Sauv. Fl. Cuba (1873) 44.
[This plant perhaps represents a species of *Acca*.]
(aka, acka)

The leaves are aromatic and are employed in warm baths for the relief of rheumatic and "nervous pains."

Psidium pyriferum L. Sp. Pl., Ed. 2 (1762) 672.
(Cited in the Relación as *Psydium pyriferum.)*
[*Psidium Guajava* L. Sp. Pl. (1753) 470.]
(sahuintu, huayabo)

The leaves and fruits possess styptic properties. Some people chew the leaves "to comfort and strengthen the teeth."

Melastomaceae

Melastoma repens Desr. in Lam. Encycl. 4 (1796) 54.
(clacla)

This plant, mixed with sundry others, provides a yellow dye.

Melastoma tomentosa Rich. in Act. Soc. Hist. Nat. Paris 1 (1792) 109.
[*Miconia tomentosa* (Rich.) D. Don in Mem. Wern. Soc. 4 (1823) 316.]
(tiriblanco)

Womenfolk make a yellow dye from this shrub, varying the shade by adding other plants.

Rhexia hispida Rich. in Act. Soc. Hist. Nat. Paris 1 (1792) 108.
(chachiquis)

This species of Rhexia is the source of a yellow dyestuff.

Rhexia repens *nom. nud.*
(olaola)

Mixed with other plants, this species provides a yellow dye.

Oenotheraceae

Fuchsia violacea *nom. nud.*
(th'ilco)

The wood yields a black dye. An infusion or decoction is believed to soothe the fevers of typhoid.

Gunneraceae

Gunnera thyrsiflora *nom. nud.*
(panke; panque)

The root is employed in tanning and to dye leather black. The mucilage from the tender stems and fresh shoots is applied to the kidneys "to lower the temperature of the blood" in severe fevers. The decoction and powder of the root are believed to be good astringents and have various therapeutic uses.

Cynomoriaceae

Cynomorium placentoeforme *nom. nud.*
(hatún puñuchrin)

Indians eat the large red aments to restore energies spent on long walks and from hard physical labour. The cold infusion is drunk for the same purpose.

Umbelliferae

Anethum parvum *nom. nud.*
(eneldo cimarrón)

The natives employ this plant medicinally in place of dill.

Apium graveolens L. Sp. Pl. (1753) 264.
(panúl; apio silvestre)

The natives of Chile eat the leaves green to stop hemorrhages of the mouth and to cure pulmonary troubles.

Ericaceae

Arbutus parviflora *nom. nud.*
(macha)

The ripe fruits, though tasty and sweet, are intoxicating when eaten in excessive amounts.

Thibaudia (?)
(machamacha)

The fruits bring on a drunkenness, if too many be eaten. The inebriation is especially severe in children.

Sapotaceae

Sideroxylon pendulum *nom. nud.*
(pumachilca)

The leaves and especially the young shoots are covered with a resin which has soothing properties. The crushed leaves and shoots are applied to bruises and contusions for relief of pain.

LOGANIACEAE

Buddleia incana R. et P. Fl. Peruv. 1 (1798) 52, t. 80, fig. b.
(Cited in the *Relación* as *Buddeja incana.*)
(quisoar, quishuara, colle)

Indians use an infusion of the terminal branches "to expel viscose and cold humours." Crushed, mixed with urine and heated over a fire, the same part of the plant is used as a cataplasm to relieve aching molars; it is applied internally and externally. Some people employ the buds to colour food.

GENTIANACEAE

Hoppea tinctoria *nom. nud.*

The leaves dye woollen, cotton and linen goods a beautiful canary yellows.

ASCLEPIADACEAE

Cynanchum leucanthum Jacq. ex. J. F. Gmel. syst. (1796) 442.
[*Sarcostemma Jacquinii* Decne. in DC. Prodr. 8 (1844) 542.]
(piochas)

The latex is said to have strong laxative properties.

CONVOLVULACEAE

Convolvulus secundus R. et P. Fl. Peruv. 2 (1799) 10, t. 117.
[*Jacquemontia unilateralis* (Roem. et Schult.) O'Donnell in Lilloa 23 (1950) 470.]

Convolvulus sepium L. Sp. Pl. (1753) 153.
[*Calystegia sepium* (L.) R. Br. Prodr. (1810) 483.]
(campanillas de lomas)

The roots of both species, in infusion, are employed by the Indians as a purgative.

Evolvulus stipulatus *nom. nud.*
(tina; membrillo)

An infusion of the leaves is valued in treating jaundice.

Ipomoea Papiru R. et. P. Fl. Peruv. 2 (1799) 11, t. 120, fig. a.
[*Ipomoea pubescens* Lam. Illustr. 1 (1791) 465, no. 2123.]

Ipomoea subtriloba R. et. P. Fl. Peruv. 2 (1799) 12.
[*Ipomoea pubescens* Lam. Illustr. 1 (1791) 465, no. 2123.]
(papyru)

The tuberous root is highly prized as a purgative, administered as an infusion. Only from one quarter to two drachmas (fresh) or forty–eight drachmas (dry) need be employed.

Mirabilis Jalapa L. Sp. Pl. (1753) 177.
(trompetillas; flor de Panamá)

A decoction of the roots has mild laxative properties.

Polemoniaceae

Periphragmos foetidus R. et P. Fl. Peruv. 2 (1799) 17.
[*Cantua pyrifolia* Juss. in Ann. Mus. Paris 3 (1804) 117.]
(huevill–huevill)

The Chileans use an infusion in clysters as a laxative.

Periphragmos uniflorus R. et P. Fl. Peruv. 2 (1799) 18.
[*Cantua ovata* Cav. Icon. 4 (1797) 43.]
(ccantu)

The uncivilized Indians esteem this shrub as a magical plant in their superstitious practices.

Verbenaceae

Lantana salvifolia Jacq. Hort. Schoenb. 3 (1798) 18, t. 285.
(mastrante)

Peruvian natives employ an infusion or a boiled potage to cure jaundice, drinking one or the other preparation in large amounts.

Verbena corymbosa R. et P. Fl. Peruv. 1 (1798) 22, t. 33.
Verbena multifida R. et P. Fl. Peruv. 1 (1798) 21.
(sandialaguén)

A decoction is taken in Chile to stimulate menstruation and to alleviate a condition which causes a burning sensation during urination.

Boraginaceae

Lithospermum tinctorium R. et P. Fl. Peruv. 2 (1799) 4, t. 114.
[*Plagiobothrys myosotoides* (Lehm.) Brand. in Pflanzenr. iv. 252 (1931) 108.]

The specific epithet refers to the custom of having horses tread upon the plant in order to prepare from it a blue dye.

Labiatae

Gardoquia canescens *nom. nud.*

Gardoquia conferta *nom. nud.*
(socconche, suyumpay, chinchi)

An infusion of this highly fragrant plant is frequently used to "relieve melancholies", for pains in the side and for nervous breakdowns. It is taken mixed with wine or with water or spirits.

Nepeta sp.
(muña; ccoa)

The natives utilize a salt water decoction to treat dropsical and gouty swellings and for liver complaints. it is valued also to assuage headaches. The warm infusion is taken as an apperitive and diuretic, to cure severe cholera and "melancholy", to cleanse the spleen and reduce oppilations.

Salvia fragrantissima *nom. nud.*
Salvia plumosa R. et P. Fl. peruv. 1 (1798) 26, t. 37.
(chenchelcoma; salvia real)

Indians occasionally eat the leaves as a vermifuge and attribute to them pectoral and antiasthmatic properties. They believe that they are capable of making sterile women fecund. The plant is frequently employed as an apperative, diuretic, vulnerary, deter-sive and tonic to build up the appetite.

NOLANACEAE

Nolana acutangula *nom. nud.*
(chaves)

This plant is considered an excellent feed for chickens.

SOLANACEAE

Cestrum virgatum R. et P. Fl. Peruv. 2 (1799) 27.
[*Cestrum Parqui* L'Herit. Stirp. Nov. (1784) 73.]
(palqui; parqui)

Chilean natives employ a decoction or infusion in treating intertmittent fevers; an infusion of the inner bark is drunk in fast periods to cure stomach ills. The berries yield a purplish blue dye.

Datura sanguinea R. et P. Fl. Peruv. 2 (1799) 15.
[*Brugmansia sanguinea* (R. et P.) D. Don in Sweet Brit. Fl. Gard. 2 (1835) 272.]
(puca-campanilla; floripondio encarnado)

The leaves are used as emollients and anodynes either in the form of cataplasms or when simply applied single and entire. The

seeds are narcotic, dulling the senses and understanding, and they are occasionally administered with evil intent as a powder in food. Some natives assert that there are those who have gone mad merely by lying down to sleep in the shade of these trees.

Datura Stramonium L. Sp. Pl. (1753) 179.
(tonco–tonco; chamico)

This plant is known in Peru as chamico because of the criminal use that the Indians are accustomed to make of it: to intoxicate each other when they feel that they have been wronged or when they are overtaken by jealousy in their love affairs. This practice has given rise to the common Peruvian adage: "Está chamicado fulano o fulana." (So–and– is under the influence of chamico.) –applied whenever a person is either pensive, taciturn, absent-minded or else too tipsy from drink or from other causes. Whilst Ruiz and his group were in Huánuco, a boy of ten gave a schoolmate of his own age powdered seeds of chamico in bread. Within a few hours, it began to exercise its narcotic effects, as though the boy had taken wine. Dombey (the French botanist accompanying Ruiz) was called in by the boy's parents to administer a remedy; but, notwithstanding the emetics and other medicines that Dombey prescribed, the boy was rendered permanently stupid and silly. Before the poisoning, he had been intelligent, keen, mischievous and full of fun in boyhood games, but his former personality was lost forever.

The natives apply the crushed leaves and seeds in a poultice to treat piles, and the effects are excellent. Some people are accustomed to drink an infusion of a few leaves to relieve pains in urinating and irritations of the skin caused by bitter and strong purgatives. The use of the crushed leaves, mixed with vinegar, is frequently made as a poultice for the spine or kidneys, in order to lower fevers and to lessen rheumatic pains and reduce the swelling of hernias.

Fabiana imbricata R. et P. Fl. Peruv. 2 (1799) 12, t. 122.
(pichi)

Plentiful on sandy banks of estuaries and rivers, this plant is believed to possess wondrous anthelmintic properties for curing sheeps and goats of pirguín, an ailment that wipes out whole flocks. This is why farmers take affected animals to pastures

where pichi abounds. With this fodder, the animals recover and fatten up in a few days.

Solanum crispum R. et P. Fl. Peruv. 2 (1799) 31, t. 158.
(natre)

According to the natives, an infusion can be used successfully in treating chavalongo, a kind of typhoid fever.

Solanum nitidum R. et P. Fl. Peruv. 2 (1799) 33, t. 163.
Solanum nutans R. et P. Fl. Peruv. 2 (1799) 34, t. 166.
Solanum oblongum R. et P. Fl. Peruv. 2 (1799) 24, t. 165, fig. b.
Solanum stellatum R. et P. Fl. Peruv. 2 (1799) 40, t. 176, fig. b.
[*Solanum hispidum* Pers. Syn. 1 (1815) 228.]
(campucassa; huircacassa)

The partially toasted leaves have the property of drawing out splinters from any part of the flesh and of helping to suppurate infected ulcers, according to native belief. Another folk –lore belief holds that the spines of *Solanum stellatum* produce blisters full of lymph, if they penetrate the flesh. This lymph turns to pus, but the blisters break open and are cured by applying the partially roasted leaves of the same plant to the affected areas.

Solanum pubescens R. et P. Fl. Peruv. 2 (1799) 36.
S. incanum R. et P. Fl. Peruv. 2 (1799) 40.
(yuruhuacta)

The natives of Peru apply the leaves upside down to bring ulcers and sores to a head. When applied under side down, the leaves are believed also to heal sores.

Solanum variegatum R. et P. Fl. Peruv. 2 (1799) 32, t. 162a.
[*Solanum muricatum* Ait. Hort. Kew, ed. 1, 1 (1789) 250.]
(pepino de la tierra; pepino del país)

When eaten in excess, the fruits cause tertian fevers and bloody stools and are harmful to those suffering from amoebas and dysentery.

BIGNONIACEAE

Jacaranda caerulea (Juss.) Griseb. Fl. Br. W. Ind. 1 (1861) 446.
(yarabisco)

The natives often use the bark of this tree to prepare anti-venereal and anti-rheumatic decoctions. The wood is employed in the preparation of cups for holding water which they are wont to

drink in great quantities; they are persuaded that this water has the same virtues as a decoction and infusion of the bark. The powdered leaves are excellent for healing ulcers, once the ulcers have been cleansed.

COLUMELLIACEAE

Columellia corymbosa *nom. nud.*

The leaves are intensely bitter and are "wonderfully efficacious" in treating intermittent fevers, according to Indian belief.

Columellia ovalis *nom. nud.*
(ollus; ulux)

This excessively bitter shrub serves as an admirable febrifuge when taken in either a cold or warm infusion.

VALERIANACEAE

Valeriana connata R. et P. Fl. Peruv. 1 (1798) 39, t. 67.
Valeriana globiflora R. et P. Fl. Peruv. 1 (1798) 43. t. 65.
Valeriana interrupta R. et P. Fl. Peruv. 1 (1798) 42, t. 67.
Valeriana lanceolata *nom. nud.*
Valeriana pilosa R. et P. Fl. Peruv. 1 (1798) 39, t. 66.
Valeriana oblongifolia R. et R. Fl. Peruv. 1 (1798) 40, t. 65.
Valeriana rigida R. et R. LF. Peruv. 1 (1798) 39, t. 65.
Valeriana thyrsiflora *nom. nud.*
(huarituru)

The natives apply the crushed roots of all of these species of Valeriana in the form of a cataplasm to set bones.

Valeriana decussata Bonp. ex Wedd. Chlor. And. 2 (1857) 19.
Valeriana paniculata R. et P. Fl. Peruv. 1 (1798) 41, t. 70. fig. a.
(macae)

The root may be employed medicinally in place of official Valeriana.

Valeriana pinnatifida R. et P. Fl. Peruv. 1 (1798) 40, t. 69.
(albergilla)

Mal de maico — stinging sores and rashes on the legs and other exposed parts of the body — is caused, according to the natives, by species of Schinus, even by the shade of the trees. It can be cured with albergilla of Spain. The albergilla is roasted in handfuls in the embers and applied as hot as can be stood to the

sores. This treatment is said to affect a cure within eight or ten days.

CAMPANULACEAE

Lobelia decurrens Cav. Icon. 6 (1801) 13, t. 521.
(contoya)

The natives use an infusion of this plant as a strong laxative. To halt its drastic action, they drink two cups of cold water.

COMPOSITAE

Achillea urens *nom. nud.*
Achillea lutea *nom. nud.*
(botoncillo)

This plant is poisonous to guinea pigs.

Anthemis pallescens (Boiss) Heldr. ex Nym. Consp. 2 (1879) 359, *in synon.*
(Cited in the Relación as *Anthemis palescens.)*
[Anthemis tinctoria L. Sp. Pl. (1753) 896.]

The roots are peppery and promote salivation. "The stimulation and acrimony of the tongue last for more than six hours."

Coreopsis sp.
Cosmos sp.
(pahuán)

"In six pints of water, cook four ounces of pahuán until the dye is well extracted. Then put in the wool soaked in alum solution and boil it together again. The dye will be orange."

Eupatorium sp.
(chilca macho)

"Take twigs of chilca macho and boil them in water together with indigo and urine. Woollens and cottons take on a greenish hue."

Eupatorium aromaticum L. Sp. Pl. (1753) 839.
(chilca)

This plant is the source of a green and a yellow dye. The crushed leaves are used to clean and heal ulcers. They are also applied to alleviate pains due to sprains and contusions.

Gnaphalium trinerve DC. Prodr. 6 (1838) 236.

Gnaphalium Viravira Mol. Sagg. Chil. (1782) 149. 354.
(viravira)

When crushed and applied as a cataplasm to contusions or ruptures, these plants are said to be very effective in "strengthening and curing the sore parts of the body."

Molina caespitosa R. et P. Syst. (1798) 206.
[*Baccharis caespitosa* (R. et. P.) pers. Syn. 2 (1807) 425.]

Molina obovata R. et P. Syst. (1798) 206.
[*Baccharis obovata* (R. et P.) DC. Prodr. 5 (1836) 408.]

Molina uniflora R. et P. Syst. (1798) 207.
[*Baccharis glutinosa* Pers. Syn. 2 (1807) 425.]
(taya hembra)

The crushed leaves are applied to sprains and contusions.

Molina concava R. et P. Syst. (1798) 203.
[*Baccharis concava* Pers. Syn. 2 (1807) 425.]

Molina linearis Less. in Linnaea 6 (1831) 139, 505.
[*Baccharis serrulata* Pers. Syn. 2 (1807) 423.]
(romerillo)

"When crushed and applied to ruptures and bruises, the leaves strengthen and aid the wounded parts."

Molina corymbosa R. et P. Syst. (1798) 210.
[*Baccharis corymbosa* (R. et P.) Pers. Syn. 2 (1807) 424.]

Molina incana R. et P. Syst. (1798) 211.
[*Baccharis thyoides* (R. et P.) Pers. Syn. 2 (1807) 425.]

Molina nitida R. et P. Syst. (1798) 204.
[*Baccharis nitida* (R. et P.) Pers. Syn. 2 (1807) 425.]

Molina prostrata R. et P. Syst. (1798) 204.
[*Baccharis prostrata* (R. et P.) Pers. Syn. 2 (1807) 424.]

Molina salicifolia R. et P. Syst. (1798) 210.
[*Baccharis salicifolia* (R. et P.) Pers. Syn. 2 (1807) 425.]

All of these species are resinous shrubs, balsamic, aromatic and tonic.

Molina emarginata R. et P. Syst. (1798) 202.
[*Baccharis emarginata* (R. et P.) Pers. Syn. 2 (1807) 424.]
(tayo macho)

Sprains and contusions are treated with this plant.

Molina scabra R. et P. Syst. (1798) 210.
[*Baccharis scabra* (R. et P.) Pers. Syn. 2 (1807) 424.]
(taya)

Women apply this plant crushed as one of the best remedies to strengthen sprains and contusions.

Molina scandens R. et P. Syst. (1798) 205.
[*Baccharis scandens* (R. et P.) Pers. Syn. 2 (1807) 424.]
(chilca)

The abundant resin of this scandent shrub is balsamic and corroborative.

Pectis trifida *nom. nud.*
(asccapichana; escoba amarga; escoba cimarrona; canchalagua cimarrona)

This plant is an excellent febrifuge and stomachic, according to native belief. The natives use an infusion of it to cure malarial fevers.

Polymnia resinifera *nom. nud.*
(puhe; taraca)

The natives employ the resin extensively to set broken bones and for neuralgias. It is applied in the form of plasters.

Santolina tinctoria Mol. Sagg. Chil. (1782) 142.
[*Cephalophora glauca* Cav. Icon. 6 (1801) 80, t. 599.]
(poquíl)

This plant is the source of a beautiful and fast yellow dye.

Scorzonera ciliata Forsk. Fl. Aegypt. Arab. (1775) 143.
[*Picridium tingitanum* Desf. Fl. Atlant. 2 (1799) 220.]

Scorzonera peruviana *nom. nud.*

These are the species of "viper grass" officially named in the Peruvian pharmacopoeia of the 18th Century.

Solidago secunda Sessé et Moç. Fl. Mex., Ed. 2 (1894) 188.
(bullel)

Solidago secunda yields a yellow dye.

Triptilion spinosum R. et P. Syst. (1798)k 185.
(Cited in the *Relación* as *Triptilion spinosa*)
(siempre viva)

With a reputation of excellent diuretic properties, this species is extensively used in treating urinary ailments.

Vermifuga corymbosa R. et P. Syst. (1798) 216.
[*Flaveria Contrayerba* Pers. syn. 2 (1807) 489.]
(chenapoya; contrayerba; matagusanos)

Employed extensively in Peru, this plant is applied as a poultice to maggot-infested sores and to wounds of beasts. When pounded up with salt, it is more efficaceous in killing maggots in animals than when used alone.

PLATE 4

HIPÓLITO RUIZ
1754–1816

BOTANICAL MUSEUM LEAFLETS
HARVARD UNIVERSITY

CAMBRIDGE, MASSACHUSETTS, JUNE 1980 VOL. 28, NO. 2

ETHNOMEDICAL, BOTANICAL AND PHYTOCHEMICAL ASPECTS OF NATURAL HALLUCINOGENS

RICHARD EVANS SCHULTES AND NORMAN R. FARNSWORTH*

ABSTRACT

More than 200 species and/or varieties of higher plants, as well as numerous species of basidiomycetes, are reported in the literature to have been used for their hallucinatory and/or euphoriant effects. Due to a paucity of research, only a few of these have been confirmed as definitely hallucinogenic in man or animals. This article reviews all of those plants now known to have a scientific basis for producing hallucinogenic effects in man or for which reliable ethnobotanical data are available to indicate that they could be hallucinogenic. Those plants alleged to be hallucinatory, but where substantive proof of this effect may be lacking, are summarily included for completeness and in the hope of stimulating investigation.

The hallucinogens of higher plant origin alone are found in 146 genera in more than 50 families. In virtually every instance in which the active constituents are known, their chemical skeletons are unique to a specific genus or to a very closely related genus.

It is interesting to note that of more than 200 species of hallucinogenic plants only two are legally prohibited from use in the United States by Federal law: *Cannabis sativa* and *Tabernanthe Iboga*. Two or three others are illegal in a few states.

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INTRODUCTION

Many reviews covering the broad subject of hallucinogenic plants have been published in recent years (Agurell 1969; Brown 1972; Der Marderosian 1966, 1967a, 1967b; Emboden, Jr., 1972, 1979; Farnsworth 1968, 1969; Furst 1972; Heim 1963b; Heim et al. 1967; Hoffer and Osmund 1967; Holmstedt and Kline 1967; Ott 1976a; Pelt 1971; Schultes 1961a and b, 1963, 1965, 1966a, 1969a, b, c, and d, 1970a, b, c, and d, 1972a and b, 1976a, b, and c, 1981; Schultes and Hofmann 1973, 1979, 1980; Stafford 1977; Wagner 1969). In addition, many reviews on various aspects of *Cannabis* and the cannabinoids have recently appeared (Abel 1976; Bailey 1974; Bech et al. 1974; Bhargava 1978; Bloch et al. 1978; Braude and Szara 1976a, 1976b; Carr et al. 1970; Goode 1970; Graham 1976; Grinspoon 1971; Hanus and Krejci 1974; Joyce and Curry 1970; Kurzman and Fullerton 1975; Lemberger and Rubin 1975; Lewis 1972; Mechoulam 1970, 1973; Mechoulam et al. 1976; Mendelson et al. 1974; Merlin 1972; Miller and Drew 1974; Morris and Farnsworth 1973; Nahas 1976; Neumeyer and Shagoury 1971; Pagel and Sanders 1976; Paxton and Crown 1970; Quimby 1974; Razdan 1973; Rubin 1975; Rubin and Comitas 1975; Saulle 1973; Schönhofea 1973; Schultes 1973; Schultes et al. 1974; Small 1976; Small and Cronquist 1976; Small 1979; Stefanis, Dornbush and Fink 1977; Turner at al. 1980; and Waller et al. 1976). The chemistry, synthesis and pharmacology of these cannabinoids have been of major concern in most of the foregoing reviews. Although the current literature of hallucinogens is voluminous (for example from 300 to 400 original research papers are being published annually on various aspects of *Cannabis* alone), our fundamental knowledge in the field of these drugs has probably not increased in proportion to the amount of research in progress.

From the vast array of species in the Plant Kingdom—variously estimated at from 200,000 to 800,000—a few have been employed in primitive societies for millennia to induce visual, auditory, tactile, and other hallucinations. Because of their unearthly effects that often defy description, they have usually been considered sacred and have played central roles as sacra-

ments in aboriginal religions (Schultes 1969a; Schultes and Hofmann, 1979).

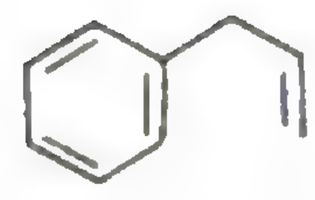
Scientific interest in hallucinogenic agents remains high in the hope of finding potentially valuable drugs for use in experimental or even therapeutic psychiatry and also because they might prove useful as tools to study biochemical origins of mental abnormalities.

While psychoactive species are widely scattered throughout the plant world, they appear to be more or less concentrated amongst the fungi and the angiosperms. The bacteria, algae, lichens, bryophytes, ferns and gymnosperms seem to be notably poor or lacking in species with hallucinogenic properties (Schultes 1969c, 1969d, 1970a, 1981; Schultes and Hofmann 1980). These hallucinogenic properties can be ascribed, likewise, to only a few kinds of organic constituents, which may be conveniently divided into two broad groups: nitrogenous and non-nitrogenous compounds (Der Marderosian 1967a; Farnsworth 1968, 1969; Schultes 1970c; Schultes and Hofmann 1973 and 1980). See Figure 1 for the basic chemical skeletons of these compounds.

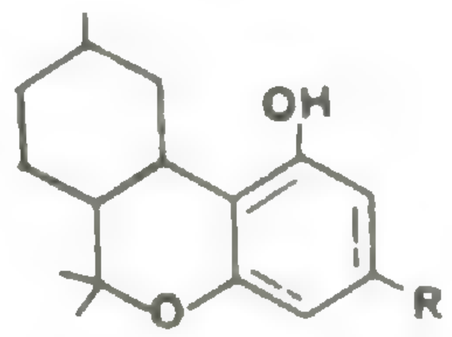
The nitrogenous compounds play by far the greater role and comprise, for the most part, alkaloids or related substances, the majority of which are or may be biogenetically derived from the indolic amino acid tryptophan. They may be classified into the following groups: 1. β-carbolines; 2. ergolines; 3. indoles; 4. isoxazoles; 5. β-phenylethylamines; 6. quinolizidines; 7. tropanes; and 8. tryptamines. Non-nitrogenous compounds, which are the active principles in at least two well known hallucinogens, include monoterpenoid chromenes and phenylpropenes.

In the study of hallucinogenic plants, two considerations must be borne in mind. One consideration reminds us that, although some of these psychoactive plants are used in primitive societies, their active chemical principles are as yet not known. The other emphasizes that man undoubtedly has utilized only a few of the species that actually do possess hallucinogenic principles. We are, as yet, far from knowing how many plants are endowed with psychotomimetic constituents, but there are certainly many more than the few purposefully employed by man as hallucinogens.

NON-NITROGENOUS HALLUCINOGENS

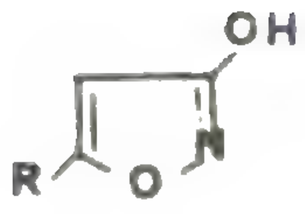


Phenylpropenes

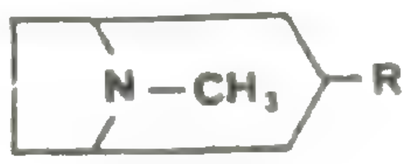


Monoterpenoid Chromenes
(Cannabinoids)

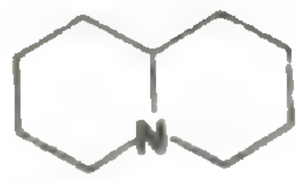
NITROGENOUS HALLUCINOGENS



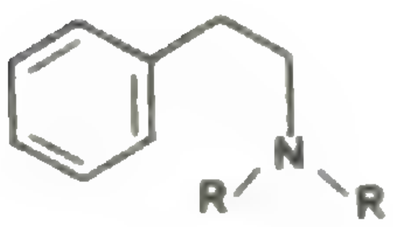
Isoxazoles



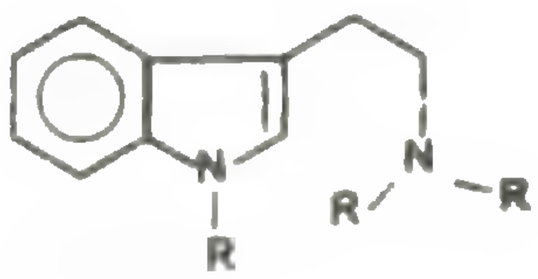
Tropanes



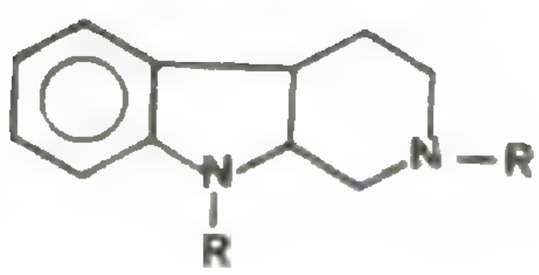
Quinolizidines



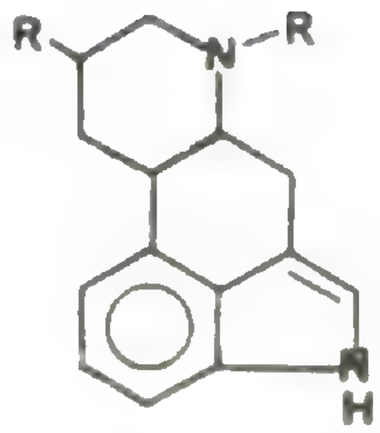
β-Phenethylamines



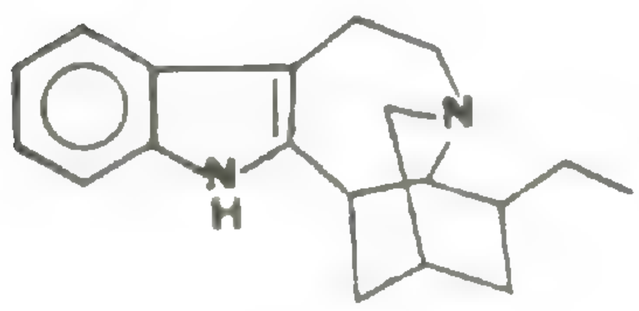
Tryptamines



β-Carbolines



Ergolines



Iboga Indoles

Figure 1. Basic skeleta of principal hallucinogens

While almost all hallucinogenic compounds are of vegetal origin, a few may be wholly or partly synthetic. The potent hallucinogen, lysergic acid diethylamide (LSD), although very closely allied chemically to the naturally occurring ergolines, has not been found in the Plant Kingdom.

NON-NITROGENOUS PRINCIPLES

1. Monoterpenoid Chromenes

Cannabaceae

Cannabis L.

The most important of the non-nitrogenous hallucinogens are the monoterpenoid chromenes, such as those found in, and apparently restricted to, the genus *Cannabis*. Products used as hallucinogens from this genus are known as *marihuana, hashish, bhang, ganja,* etc.

Various aspects of *Cannabis* have been authoritatively reviewed in recent years, including the botany, chemistry, pharmacology, synthesis of active and inactive cannabinoids, metabolism in man and animals, etc. (Abel 1976; Anderson 1974; Bailey 1974; Bech et al. 1974; Bhargava 1978; Bloch et al. 1978; Braude and Szara 1976a and b; Carr et al. 1970; Clark and del Giudice 1978; Graham 1976; Hanus and Krejci 1974; Iversen, Iversen and Snyder 1978; Iversen, Iversen and Snyder 1978; Joyce and Curry 1970; Clark and del Giudice 1978; Graham 1976; Lemberger and Rubin 1975; Lewis 1972; Mechoulam 1970, 1973; Mechoulam et al. 1976; Mendelson et al. 1974; Miller and Drew 1974; Morris and Farnsworth 1973; Neumeyer and Shagoury 1971; Paxton and Crown 1972; Quimby 1974; Razdan 1973; Salemink 1978; Salzman 1979; Saulle 1973; Schonhofea 1973; Schultes 1973; Schultes et al. 1974; Small 1976 and 1979; Small and Cronquist 1976; Stueck 1979; and Turner et al. 1980). Of special interest is a recent annotated bibliography on marihuana, covering all periodical references appearing in the scientific literature from 1964 through 1974 (Waller et al. 1976).

Since more has been published on *Cannabis* and its constituents than on any other natural hallucinogen, this section must be treated in greater detail than others.

a. THE FORENSIC-TAXONOMIC DISPUTE. Only during the past seven or eight years has the importance of the monotypic *vs.* polytypic status of *Cannabis* demanded popular attention. The reason has its roots in legal arguments, especially in the United States. These arguments hinge on the question of whether forensic material of *Cannabis* can be identified as coming from *C. sativa* L., when the possibility of the existence of other species is real, if not actual (Anderson 1974; Emboden 1974; Schultes et al. 1974). In most states and in several countries, the law defines marihuana as a product only of *C. sativa*. If more than one species exists, legal authorities must prove by identification that suspect material contains *C. sativa* and is not actually any of the other species (Fullerton and Kurzman 1974).

Since the usual methods for establishing the identity of a marihuana sample include (a) microscopy, (b) a colour test, such as the Duquenois-Levine test and (c) some type of chromatographic evidence, i.e. thin-layer chromatography, gas-liquid-chromatography, etc., one must have a knowledge of the results that would be obtained with these analyses using authenticated specimens of all acknowledged species of *Cannabis;* otherwise, the presence of *C. sativa* cannot be legally proved. It should also be borne in mind that when, as is usually the case with most legally confiscated samples of *Cannabis*, most if not all diagnostic specific characters of the original plant are altered or destroyed, identification to species becomes difficult or impossible. Then gross morphological features of the source plant, i.e. growth habit, which are frequently critical for proper identification of the sample are, of course, not discernable. Finally, the structure of the wood offers numerous reliable characters to differentiate species, but wood is rarely if ever present in forensic material of *Cannabis*. (Anderson 1974).

Virtually no state or federal law takes into account that a mere botanical description or identification of *Cannabis sativa* (or any other species of *Cannabis*) carries with it the ability of the plant to produce hallucinogenic, euphoric or other effects in humans using it for such purposes. Consequently, a situation could conceivably come about in which a person may receive legal punishment for possessing material "identified" as *C. sativa*, when the substance is incapable of a drug abuse potential

because it contains none, or too little, of the chemical constituents to elicit the biological effect that the law was meant to control. The fact that strains of *C. sativa* have been found which are virtually devoid of Δ^8 and/or Δ^9-tetrahydrocannabinols, the active principles, is well documented in the scientific literature (Small 1979).

There is still disagreement concerning the botanical classification of *Cannabis*. It has been put into different families: in the Urticaceae (Nettle Family) in earlier periods; then into the Moraceae (Mulberry Family) during the last century and even today; finally, into a separate family—the Cannabaceae—together with *Humulus,* the hop plant, which assignment is now widely accepted. The major taxonomic problem, however, concerns the number of species in the genus—whether one or several. While botanists have generally tended to believe that *Cannabis* is monotypic, the polytypic concept is not new, going back to 1785. A number of Russian botanists have long held that *Cannabis* has at least three species. Schultes and co-workers (Schultes et al. 1974) have studied the problem in the literature, have examined hundreds of herbarium specimens, have studied plants from many parts of the world cultivated at the University of Mississippi and in the field in several localities, especially in Afghanistan. They are of the opinion that three species do exist: *C. sativa, C. indica* Lam. and *C. ruderalis* Jan. More recently, Anderson (Anderson 1974) studied the wood anatomy of *Cannabis.* Although few samples were examined, the magnitude of the differences was "impressive in a system as conservative as wood". His studies convinced him that he was dealing with two species: *C. sativa* and *C. indica.* Material of *C. ruderalis* was not then available. Emboden, who has also investigated *Cannabis* in the field and herbarium, has accepted the polytypic concept (Emboden 1974 and 1981).

Small has defended the monotypic concept, stating correctly: "It should be understood that the taxonomic debate concerning *Cannabis* represents the first rigorous examination of the implications of biological taxonomy for legislation." He then discussed for a forensic readership (Small 1976) the concepts involved in plant classification and nomenclature, the degree of subjectivity involved, ambiguities of biological names and the

extent and nature of taxonomic disagreements. His major point claims that the whole controversy is based on semantics, as indicated in the title: "The Forensic Taxonomic Dispute on *Cannabis:* Semantic Hokum". In a recent two-volume book, Small emphasizes again his belief that the biological question of whether the genus is monotypic or polytypic is merely one of semantics (Small 1979).

But, in a technical article in 1976, Small (Small 1976) meticulously summarizes his research in cytology and breeding behaviour, chemical variation, akene morphology and taxonomy, reaching the conclusion that *Cannabis* consists of one very variable species. This variation, he believes, is due primarily to human activity. He discerns two widespread classes: a northern group of "relatively limited intoxicant potential" and a more southern group of stronger intoxicant potential. These two groups are separated as distinct subspecies of *C. sativa.* Within each subspecies "two parallel phases"—the "weedy naturalized or indigenous" and the "cultivated or spontaneous"—are recognized as four named varieties.

Small has, in effect, accepted the proposition that the genus has several genetically stable entities, but he prefers to call them "subspecies" instead of "species" (Small 1979)—obviously representing a difference of weight in characters of classification (frequent in taxonomy) and approaching the category of "semantics", which he previously so strongly decried (Emboden 1981).

The whole legal problem could easily be solved if the law controlling "marihuana" were more logically worded to control "all species of *Cannabis*". Given the different viewpoints among botanists as to what constitutes a species, subspecies or variety, it may be long before agreement is reached in the taxonomic field, although almost all botanists who have recently considered the problem have concluded that the genus is indeed polytypic.

b. MONOTERPENOID CHROMENES OF CANNABIS. Since chemical studies on *Cannabis* have rarely, if ever, been published on the basis of vouchered specimens, these studies cannot be documented in a manner to permit unambiguous identification. We are obliged, therefore, to present a review of the chemical

constituents in this plant as if all specimens analyzed were referable *C. sativa,* realizing that this may or may not be the case. There is little dispute that the major active hallucinogen in *Cannabis* is Δ^9-tetrahydrocannabinol. To date, at least 50 cannabinoids, or rearranged cannabinoids, have been isolated from the genus. Most of these are trace constituents, and only a few are judged to be artefacts. The structures of the major cannabinoids are presented in Figures 2–11.

C. NON-CANNABINOID CONSTITUENTS OF CANNABIS. Although little is known of the contribution of non-cannabinoids to the biological activity of marihuana, the constituents recognized will be presented for the sake of completeness.

Flavonoids. Cosmosioside, orientin and vitexin (Paris and Paris 1973); and 2″-0-glucopyranosylorientin and 2″-0-glucopyranosylvitexin (Segelman et al. 1978).

Triterpenes. Epi-friedelanol, friedelanol and friedelin (Slatkin et al. 1971).

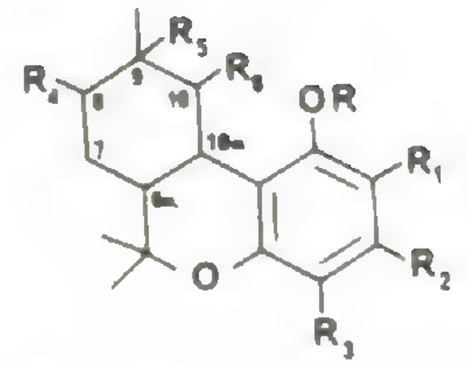
Sterols. Campesterol (Fenselau and Hermann 1982; Foote and Jones 1974; Slatkin et al. 1975a; and Turner and Mole 1973), β-sitosterol (Fenselau and Hermann 1972; Foote and Jones 1974; Itokawa et al. 1975; Slatkin et al. 1975a; Turner and Mole 1973); stigmasta-4,22-dien-3-one, stigmast-5-en-3-β-ol-7-one, stigmasta-5,22-dien-3-β-ol-7-one, campest-4-en-3-one and stigmast-4-en-3-one (Slatkin et al. 1975a); and ergosterol and 5 α-stigmasta-7,24(28)-dien-3β-ol (Novotny et al. 1976); 5α-stigmast-22-en-3-one, 5α-stigmasta-3-one, campesterol, and 5α-ergostan-3-one (Itokawa et al. 1975).

Essential Oil Analyses. Several monoterpenes, sesquiterpenes, phenylpropanoids and phenolic compounds (Bercht et al. 1971 and 1974; Hendriks et al. 1975; Hood et al 1973; Malingre et al. 1975; Stahl and Kunde 1973; Strömberg 1974).

Aliphatic Hydrocarbons. C_{22}-C_{31} *n*-alkanes (Adams and Jones 1973; Mobarak et al. 1974a, 1974b; and Rasmussen 1975); *iso*-alkanes C_{25}; C_{27} and C_{29} (Adams and Jones 1973) and *anteiso*-alkanes C_{26}, C_{28} and C_{30} (Adams and Jones 1973).

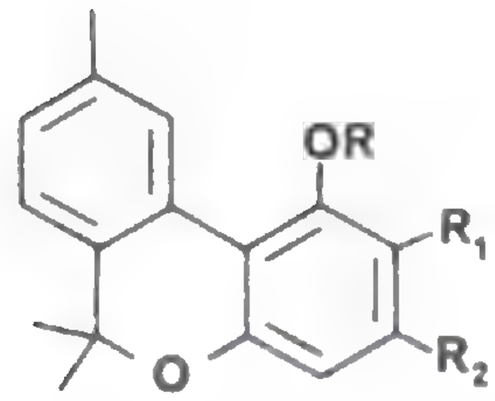
Fatty Acids. Several normal fatty acids have been reported (Itakawa et al. 1975; Romanenko 1974; Stepanova 1973).

Amino Acids, Proteins, Nucleosides. The following amino



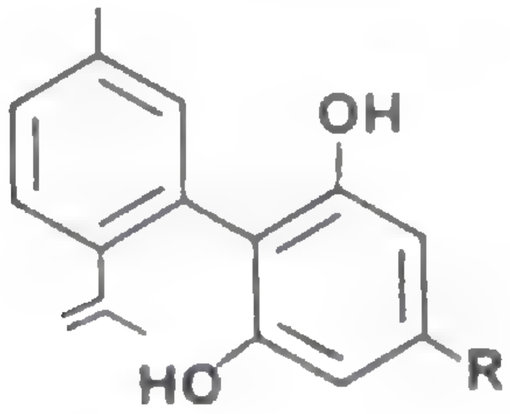
Cannabinoid	R	R_1	R_2	R_3	R_4	R_5	R_6	Other	References
(-)-trans-^{9}-Tetrahyrocannabinol	H	H	C_5H_{11}	H	H	H	H	Δ^9	Gaoni and Mechoulam 1964a
$\Delta^{10(10a)}$-Tetrahydrocannabinol	H	H	C_5H_{11}	H	H	H	H	$\Delta^{10(10a)}$	Stromberg 1976
Δ^9-Tetrahydrocannabinolic Acid A	H	COOH	C_5H_{11}	H	H	H	H	Δ^9	Korte et al. 1965
Δ^9-Tetrahydrocannabinolic Acid B	H	H	C_5H_{11}	COOH	H	H	H	Δ^9	Mechoulam et al. 1969
Δ^9-Tetrahydrocannabinol Methyl Ether	CH_3	H	C_5H_{11}	H	H	H	H	Δ^9	Hanus 1974
3,4,-cin-Δ^9-Tetrahydrocannabinol	H	H	C_5H_{11}	H	H	H	H	Δ^9; 3,4-cis	Smith and Kempfert 1972
$\Delta^{10(10a)}$-Cannabitriol	H	H	C_5H_{11}	H	H	OH	OH	$\Delta^{10(10a)}$	Chan et al. 1976
(-)-trans-Δ^8-Tetrahydrocannabinol	H	H	C_5H_{11}	H	H	H	H	Δ^8	Gaoni and Mechoulam 1971
Δ^8-Tetrahydrocannabinolic Acid B	H	H	C_5H_{11}	COOH	H	H	H	Δ^8	Hanus 1974
Δ^8-Tetrahydrocannabitriol	H	H	C_5H_{11}	H	H	OH	OH	Δ^8	Stromberg 1976
(±)-$\Delta^{6a(10a)}$-Tetrahydrocannabinol	H	H	C_5H_{11}	H	H	H	H	$\Delta^{6a(10a)}$	Elsohly et al. 1978a
(±)-8,9-Dihydroxy-$\Delta^{6a(10a)}$-Tetrahydrocannabinol	H	H	C_5H_{11}	H	OH	OH	H	$\Delta^{6a(10a)}$	Elsohly et al. 1978a
(-)-10-Ethoxy-9-hydroxy-$\Delta^{6a(10a)}$-tetrahydrocannabinol	H	H	C_5H_{11}	H	H	OH	O-Et	$\Delta^{6a(10a)}$	Elsohly et al. 1977
10-Oxo-$\Delta^{6a(10a)}$Tetrahydrocannabinol	H	H	C_5H_{11}	H	H	H	=O	$\Delta^{6a(10a)}$	Friedrich-Fiechtl and Spiteller 1975
Δ^9-Tetrahydrocannabivarol	H	H	C_3H_7	H	H	H	H	Δ^9	Merkus et al. 1971a
Δ^9-Tetrahydrocannabivarolic Acid	H	COOH	C_3H_7	H	H	H	H	Δ^9	Paris et al. 1973
Δ^9-Tetrahydrocannabiorcol	H	H	CH_3	H	H	H	H	Δ^9	Vree et al. 1971a

Figure 2. Cannabinoid Structures — THC Type



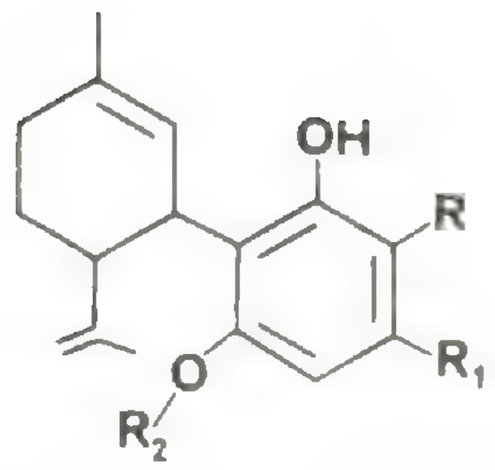
Cannabinoid	R	R_1	R_2	References
Cannabinol	H	H	C_5H_{11}	Adams et al. 1940
Cannabinolic Acid	H	COOH	C_5H_{11}	Mechoulam and Gaoni 1965
Cannabinol Methyl Ether	CH_3	H	C_5H_{11}	Bercht et al. 1973a
Cannabivarol	H	H	C_3H_7	Merkus 1971b Vree et al. 1971b
Cannabiorcol	H	H	CH_3	Vree et al. 1971a

Figure 3. Cannabinoid Structures — Cannabinol Type



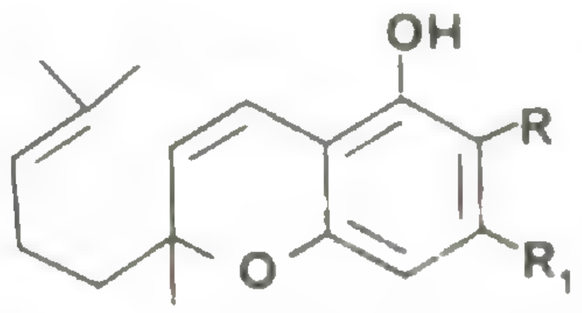
Cannabinoid	R	References
Cannabinodiol	C_5H_{11}	Van Ginneken et al. 1972; Lousberg et al. 1977
Cannabinodivarol	C_3H_7	Vree et al. 1972a

Figure 4. Cannabinoid Structures — Cannabinodiol Type



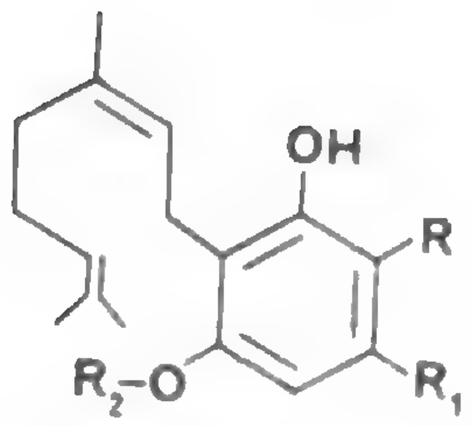
Cannabinoid	R	R_1	R_2	Reference
Cannabidiol	H	C_5H_{11}	H	Adams et al. 1940
Cannabidiolic Acid	COOH	C_5H_{11}	H	Krejci and Santavy 1975
Cannabidiol Monomethyl Ether	H	C_5H_{11}	CH_3	Shoyama et al. 1972a
Cannabidiolic Acid Monomethyl Ether	COOH	C_5H_{11}	CH_3	Shoyama et al. 1970
Cannabidivarol	H	C_3H_7	H	Vollner et al. 1969
Cannabidivarolic Acid	COOH	C_3H_7	H	Waller 1976
Cannabidiorcol	H	CH_3	H	Vree et al. 1971a

Figure 5. Cannabinoid Structures — Cannabidiol Type



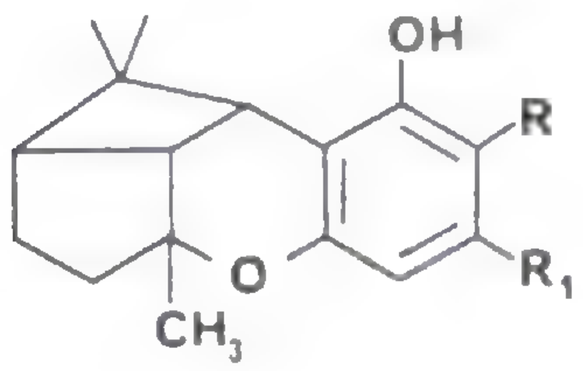
Cannabinoid	R	R_1	Reference
Cannabichromene	H	C_5H_{11}	Claussen et al. 1966b
Cannabichromenic Acid	COOH	C_5H_{11}	Shoyama et al. 1968
Cannabivarichromene	H	C_3H_7	de Zeeuw et al. 1973
Cannabichromevarol	OH	C_3H_7	Shoyama et al. 1975
Cannabichromevarolic Acid	COOH	C_3H_7	Shoyama et al. 1977

Figure 6. Cannabinoid Structures — Cannabichromene Type



Cannabinoid	R	R_1	R_2	References
Cannabigerol	H	C_5H_{11}	H	Gaoni and Mechoulam 1964b
Cannabigerolic Acid	COOH	C_5H_{11}	H	Mechoulam et al. 1969
Cannabigerol Monomethyl Ether	H	C_5H_{11}	CH_3	Yamuchi et al. 1968
Cannabigerolic Acid Monomethyl Ether	COOH	C_5H_{11}	CH_3	Shoyama et al. 1970
Cannabigerovarol	H	C_3H_7	H	Shoyama et al. 1975
Cannabigerovarol Monomethyl Ether	H	C_3H_7	CH_3	Bercht et al. 1973a
Cannabigerovarolic Acid	COOH	C_3H_7	H	Shoyama et al. 1977

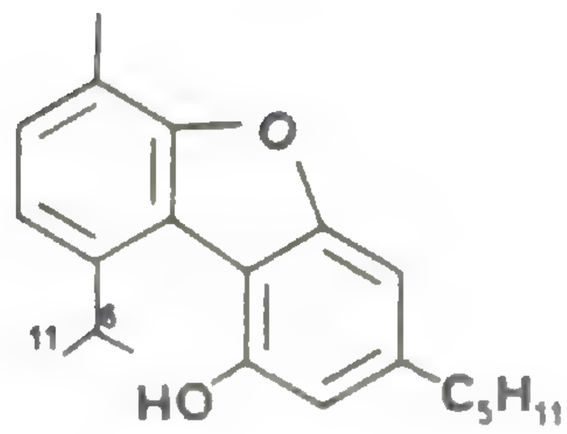
Figure 7. Cannabinoid Structures — Cannabigerol Type



Cannabinoid	R	R_1	References
*Cannabicylol (Cannabipinol)	H	C_5H_{11}	Claussen et al. 1967
*Cannabicyclolic Acid	COOH	C_5H_{11}	Shoyama et al. 1972b
Cannabivaricyclol	H	C_3H_7	Vree et al. 1972a, 1927b

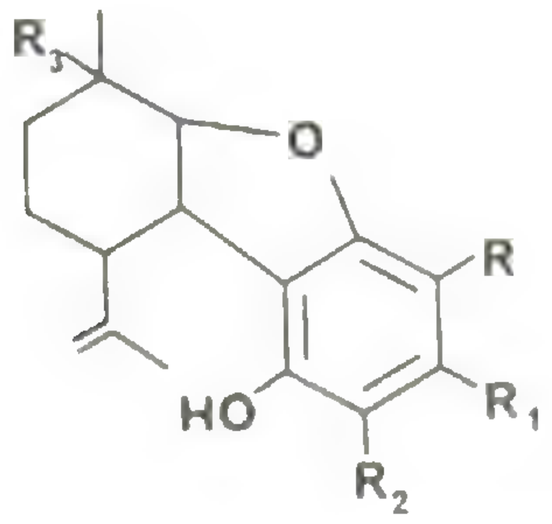
*Probably artifacts

Figure 8. Cannabinoid Structures — Cannabicyclol Type



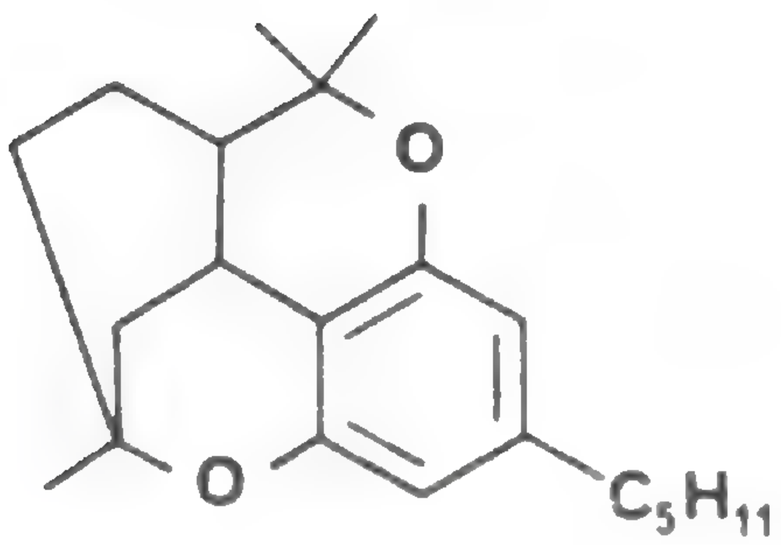
Cannabinoid		Reference
Cannabifuran		Friedrich-Fiechtl and Spiteller 1975
Dehydrocannabifuran	$\Delta^{6(11)}$	Friedrich-Fiechtl and Spiteller 1975

Figure 9. Cannabinoid Structures — Cannabifuran Type

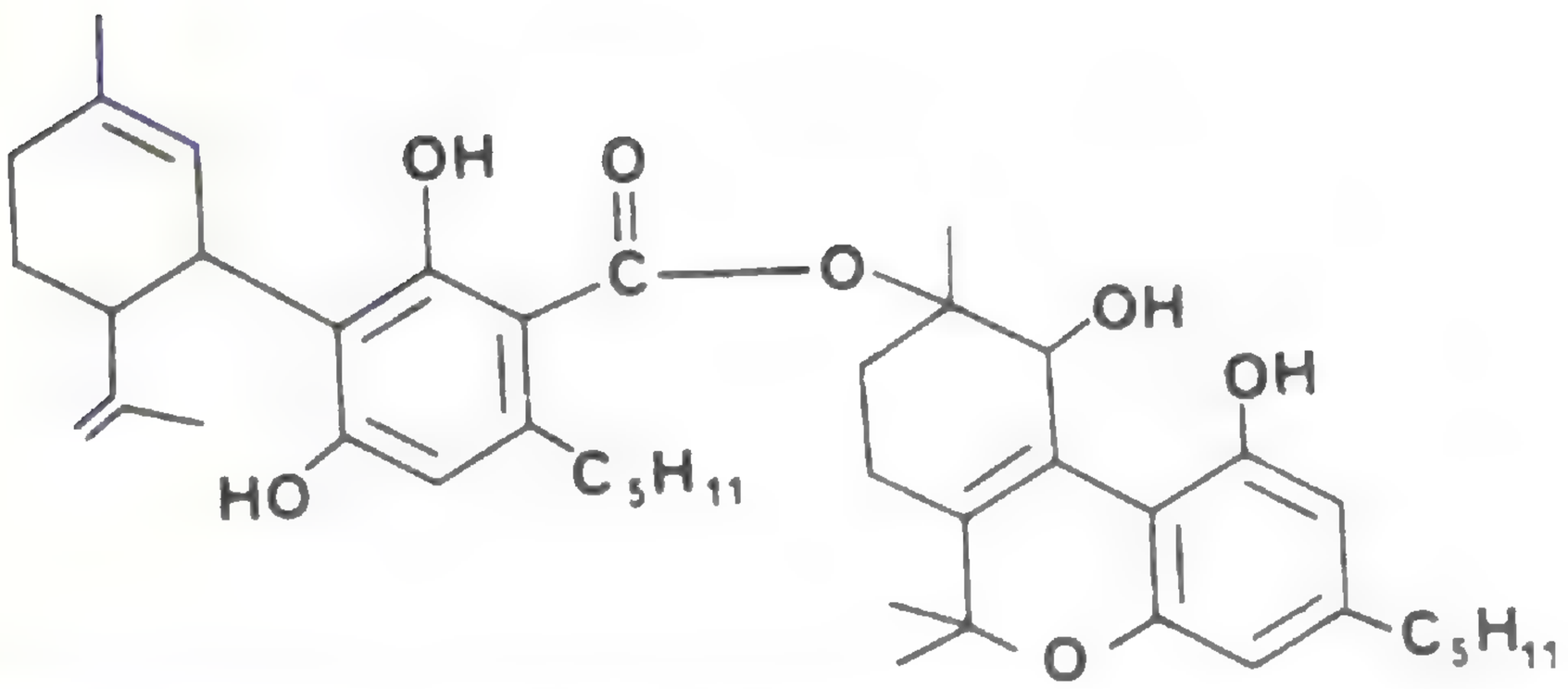


Cannabinoid	R	R_1	R_2	R_3	Reference
Cannabielsoic Acid A	H	C_5H_{11}	COOH	OH	Shani and Mechoulam 1974
Cannabielsoic Acid B	COOH	C_5H_{11}	H	OH	Shani and Mechoulam 1974
Cannabielsoin	H	C_5H_{11}	OH	OH	Bercht et al. 1973a
C_3-Cannabielsoin	H	C_3H_7	OH	OH	Grote and Spiteller 1978a
C_3-Cannabielsoic Acid B	COOH	C_3H_7	H	OH	Grote and Spiteller 1978a

Figure 10. Cannabinoid Structures — Cannabielsoin Type



Cannabicitran (Bercht et al. 1974)



Cannabidiolic Acid Tetrahydrocannabitriol Ester (von Spulak et al. 1968)

Figure 11. Cannabinoid Stuctures — Miscellaneous Types

acids have been identified in *Cannabis:* alanine, aspartic acid, glutamic acid, glycine, serine, arginine, isoleucine, phenylalanine, proline and tyrosine (Paris et al. 1975); cystine, methionine and tryptophan (Wallace et al. 1973); and histidine, leucine, lysine, threonine and valine (Obata et al. 1960). The amino acid sequence of hemp cytochrome-C has been reported as Lys-Thy-Lys-Cys-Ala-Glu-Cys-His-Thr-Val-Gly-Arg-Gly-His (Wallace et al. 1973).

The fruits of *Cannabis* are reported to contain edestin (St. Angelo et al. 1969; Stockwell et al. 1964); zeatin and zeatin nucleoside (Rybicka and Engelbrecht 1974); edestinase (St. Angelo et al. 1969) and glucosidase (emulsin) (Leoncini 1931). *Cannabis* leaves have yielded a water-soluble glycoprotein (Hillestad and Wold 1977; Hillestad et al. 1977a), and the dormant

cotyledons of *Cannabis* contain adenosine-5-phosphatase (Bargoni and Luzzati 1956).

Cyclitols and Sugars. Arabinitol, bornesitol, erythritol, fructose, glucose, glycerol, D-manno-heptulose, altro-heptulose, (+)-inositol, myo-inositol, D-glycero-D-manno-cotulose, ribitol, sucrose and xylitol (Haustveit and Wold 1973); quebrachitol (Adams et al. 1940; Haustveit and Wold 1973; and Krishnamurty and Kaushal 1976); galactosamine (the first record in higher plants) (Wold and Hillestad 1976) and vomifoliol and dihydrovomifoliol (Bercht et al 1976a); and glucose, fructose, galactose, myo-inositol, galactitol and mannitol (Krishnamurty and Kaushal 1976).

Phenolics. p-Coumaric, *p*-hydroxybenzoic and vanillic acids (Paris and Paris 1973); and *p*-vinylphenol (probably an artefact) (Burstein et al., 1976).

Alkaloids and Related Substances. Cannabamines A, B, C and D (structures undetermined) (Klein et al. 1971; Caolo et al. 1979a and 1979b) have reported on the isolation of afileramine, an alkaloid from *Zanthoxylum punctatum* Vahl bearing a direct structural relationship to the cannabinols. A second cannabinol-like alkaloid was isolated by these workers from the same plant, which presented an identical mass spectrometric fragmentation as cannabamine B, and a structure was postulated; cannabisativine (Lotter et al. 1975; Slatkin et al. 1975b, Turner et al. 1976), anhydrocannabisativine (Elsohly et al. 1978b); hexadecanamide (Smith and Kempfert 1977); piperidine (Obata et al. 1960; Salemink et al. 1966 and Bercht and Salemink 1969); hordenine (El-Feraly and Turner 1975; and Elsohly and Turner 1976 and 1977); ammonia, methylamine, ethylamine, *n*-propylamine, *n*-butylamine, *iso*-butylamine, *sec*-butylamine, dimethylamine, diethylamine and pyrrolidine (Lousberg and Salemink 1973), with the following being tentatively identified: *iso*-amylamine, *β*-phenylethylamine, *n*-pentylamine, cadaverine, ethnolamine (or histamine) and benzylamine (or tyramine) (Lousberg and Salemink 1973); choline (El-Feraly and Turner 1975; Mole and Turner 1973, 1974; Salemink et al. 1966; and Turner and Mole 1973); neurine (El-Feraly and Turner 1975; Mole and Turner 1973, 1974; Shoyama et al. 1968; and Turner and Mole 1973);

trigonelline (Mole and Turner 1974; Salemink et al. 1966; Schulze and Frankfurt 1894); N-(*p*-hydroxy-*β*-phenethyl)-*p*-hydroxy-*trans*-cinnamide (Slatkin et al. 1971); and L-(+)-isoleucine betaine (Lousberg and Salemink 1973).

Spiro-compounds. Recently, several spiro-compounds have been isolated from *Cannabis sativa* of various geographical origins, such as cannabispirone (El-Feraly et al. 1977; Bercht et al. 1976b); dehydrocannabispiran (cannabispirenone) (Bercht et al. 1976b); cannabispiranol (*β*-cannabispiranol) (Boeren et al. 1977; Crombie et al. 1978); cannabispiradienone (Crombie et al. 1979) and acetyl cannabispiranol (Shoyama and Nishioka 1978).

Dihydrostilbenes. A group of substituted dihydrostilbenes of biogenetic interest has been isolated from *Cannabis sativa,* including cannabiprene, 3,3′-dihydroxy-4,5′-dimethoxybibenzyl and 3,4′-dihydroxy-5-methoxybibenzyl (Crombie and Crombie 1978) and 3′,4′-dihydroxy-5,5′-dimethoxy-3-(3-methylbut-2-enyl)-bibenzyl (Kettenes-van den Bosch et al. 1978).

Phenanthrenes. A single example of a phenanthrene derivative has been isolated from *Cannabis sativa,* which has been named cannabidihydrophenanthrene (Crombie et al. 1979).

Coumarones. Two coumarone derivatives, cannabicoumarononе and cannabicoumarononic acid (Grote and Spiteller 1978b) have recently been isolated from *Cannabis sativa.*

Current information suggests that *Cannabis* exists as three main phenotypes (Fetterman et al. 1971). Type I contains usually 0.3% of Δ^9-THC, and these plants most frequently originate from countries south of latitude 30° N. Type I contains also low amounts of cannabidiol (0.5%). Type II *Cannabis* likewise usually has a high Δ^9-THC content (0.3%), but more than 0.5% cannabidiol. Type III *Cannabis* in general has 0.3% Δ^9-THC and 0.5% cannabidiol. Both types II and III appear to originate in countries north of latitude 30° N. To date, no one has correlated cannabinoid content with definite taxonomic concepts.

d. PHARMACOLOGY OF CANNABIS. The public uproar surrounding *Cannabis* and its constituents represents a classic example of legal hindrance to drug development. Societal, political factors and irresponsible publicity have compounded the problem.

Research into potential new medical uses of cannabinoids has probably been reduced as a result of the hindrances imposed by legal restraints on the study of *Cannabis*. Yet this research is promising. For example, Δ^9-THC has been reported to be very effective in reducing many of the side effects attendent upon the administration of potent antitumour chemotherapy in humans (Davies et al. 1974; Sallan et al. 1975). Likewise, the beneficial effect of *Cannabis* smoking in the treatment of glaucoma is difficult to dismiss (Hepler and Frank 1971; Hepler et al. 1972; Shapiro 1974). The analgesic (Buxbaum 1972; Bicher and Mechoulam 1968; Cortex Jr. et al. 1966; Kaymakcalan et al. 1974; Kosersky et al 1973; Parker and Dubas 1972), antiinflammatory (Kosersky et al. 1973; Sofia et al. 1974), anticonvulsant effects (Carlini et al. 1973; Cely et al. 1974; Chesher and Jackson 1974; Conscroe and Man 1973; Conscroe et al. 1973; Corcoran et al. 1973; Karler 1973; Karler et al. 1973, 1974; Man and Conscroe 1973; McCaughran et al. 1974; Mincs et al. 1973; Sofia et al. 1971; Tannhauser and Izquierdo 1974; Turkanis et al. 1974; Wada et al. 1973), and antitumour activity (Bhargava 1978; Braude and Szara 1976a, 1976b; Carchman et al. 1976; Desoize and Nahas 1976; Harris et al. 1974, 1976) of certain of the cannabinoids in laboratory animals might justify clinical trial in man. It has been suggested that *Cannabis* might be useful as an agent in rehabilitating alcoholics (Scher 1971) and in the treatment of asthma (Arey 1973) as well as for other conditions (Beaconsfield et al. 1975). In addition, recently reported effects of certain of the cannabinoids in the inhibition of naloxone-induced withdrawal in morphine-dependent animals may offer promise in the treatment of narcotic addiction (Bhargava 1976a and b).

Pharmaceutical firms and other entities are actively engaged in synthesizing analogs of the cannabinoids, (Pars et al. 1976; Razdan and Dalzell 1976; Razdan et al. 1976a, 1976b; Winn et al. 1976; Kurth et al., 1976), instead of further exploring uses of the natural parent compounds. Patent difficulties and stability problems of the natural derivatives as well as legal and political implications have no doubt played an important role in this decision.

Mechoulam and co-workers (1976) have summarized the current status of our knowledge of structure-activity relationships in the cannabinoid area. With regard to psychotomimetic activity, the structural requirements may be summarized as follows:

1. A benzopyran (or xanthene) type of structure with a hydroxyl group at the 1 aromatic position and an alkyl group on the 3 aromatic position seem to be required. Opening of the pyran ring leads to complete loss of activity.

2. The aromatic hydroxyl group has to be free or esterified. Blocking of the hydroxyl group as an ether inactivates the molecule.

3. When alkyl groups are substituted on the phenolic ring at C-3, activity is retained. Substitution at C-5 eliminates activity. Electronegative groups such as carboxyl, carbomethoxyl and acetyl at either C-3 or C-5 eliminate activity.

4. A certain length of the aromatic side chain at C-3 is a requirement for activity. Branching of the side chain may lead to substantial increase in potency. A 1,2-dimethylheptyl or a 1,1-dimethylheptyl side chain seems to be best.

5. Not all of the theoretically possible THC's are active. Thus, Δ^8 and Δ^9-THC are active in the 3R,4R series only; Δ^7-THC and Δ^{11}-THC are inactive; Δ^{10a}-THC is active; Δ^9-3,4-*cis*-THC is inactive.

6. The terpenoid and pyran rings may be considerably modified. These modifications do not seem to follow a regular pattern, and even tentative rules cannot yet be put forward.

e. NEW POTENTIAL HAZARD OF MARIHUANA USE. Recent attempts to increase the "potency" of marihuana by spraying whole growing plants with liquid fertilizer have been reported. It has been pointed out that this practice could be dangerous on the theoretical grounds that such treatment might cause the formation of carcinogenic N-nitrosamines (Farnsworth and Cordell 1976). Fertilizers containing nitrate can potentially initiate N-nitroso derivitization of secondary amines known to be present in marihuana, with the reaction being accelerated by the presence of any compounds with *o*-hydroxy phenolic (catechol) groups. It has recently been shown that marihuana does contain

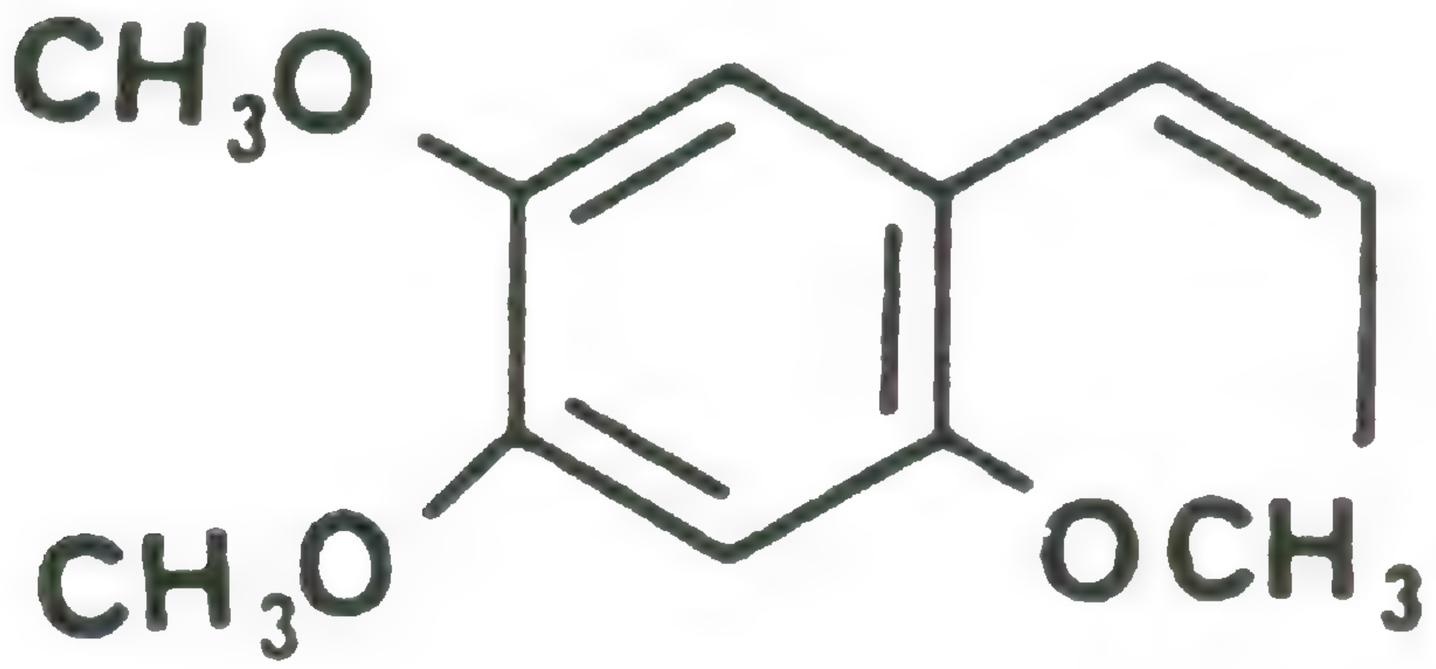
at least one flavonoid with the *o*-hydroxy phenolic moiety. Thus, on theoretical grounds, one would predict the formation of carcinogenic N-nitroso compounds in marihuana treated with nitrate-containing liquid fertilizers. The implications of this possibility are obvious.

2. Phenylpropenes

Araceae

Acorus L.

There is some evidence that Indians of northern Canada chew the root of *Acorus Calamus* L.—*flag root, rat root, sweet calomel*—for its medicinal and stimulant properties. In excessive doses, this root is known to induce strong visual hallucinations (Hoffer and Osmund 1967). The hallucinogenic principles are reported possibly to be α-asarone (I) and β-asarone (II) (Schultes 1970c). There are two species of *Acorus* occurring in the north temperate zone and in the warmer parts of both hemispheres.



I

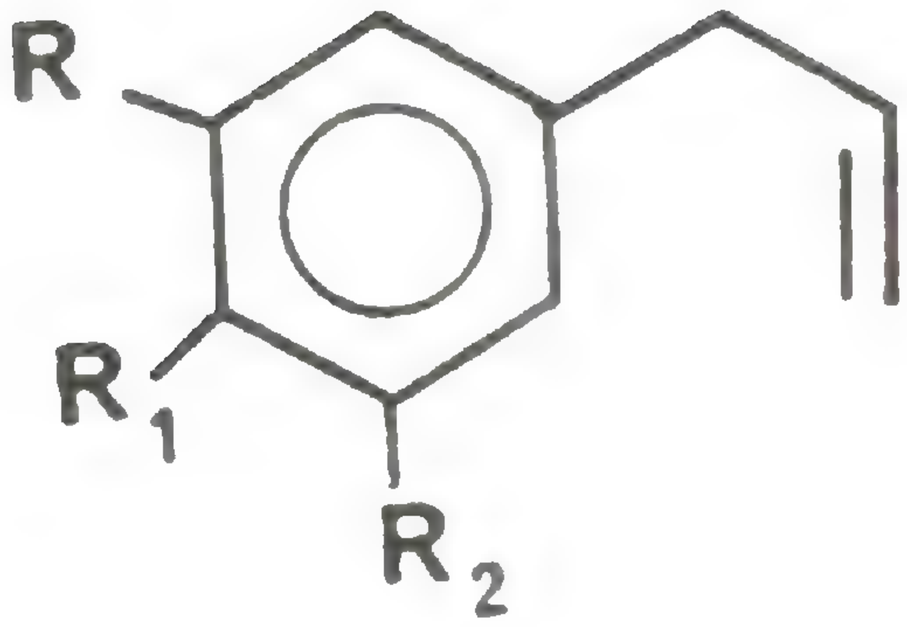
II (Geometric isomer of I)

Myristicaceae

Myristica Gronov.

The tree that yields the spices nutmeg and mace—*Myristica fragrans* Hout.—is thought to have been employed aboriginally as a narcotic in southeastern Asia, where it is native. It is sometimes used as an hallucinogen in sophisticated circles in Europe and North America and has occasionally become a problem in prisons in the United States (Panayotopoulos and Chisholm 1970; Weil 1965, 1966, 1967; Weiss 1960; Williams and West 1968). The toxicity of nutmeg, when either accidentally or knowingly ingested, is well documented (Green Jr. 1959; Painter et al. 1971; Payne 1963).

Although the toxicology of nutmeg has not yet been fully explained, the psychoactive principles are associated probably with the essential oil present in the seed and aril. The composition of the essential oil is highly variable, both qualitatively and quantitatively, but it does contain fatty acids, terpenes and aromatic compounds, especially arylbenzenoid derivatives. The major constituents of the essential oil appear to be elemicin (III), myristicin (IV) and safrole (V). Undoubtedly, all three of these compounds contribute to the psychotomimetic effect of nutmeg. All of these compounds can be visualized as precursors of amphetamines and might exert a sympathomimetic effect following biotransformation. When nutmeg essential oil was injected into mice, a strong psychotomimetic effect was observed, which was greater than that produced by myristicin alone (Kalbhen 1971).



	R	R_1	R_2
III	OCH_3	OCH_3	OCH_3
IV	$-O-CH_2-O-$		OCH_3
V	$-O-CH_2-O-$		H

Preliminary evaluation of elemicin (Schlemmer et al. 1973) has shown that it produces the same behavioural effect in mice as do many of the known hallucinogens, when evaluated by the Corne and Pickering model (Corne and Pickering 1967). This observation suggests that elemicin, in addition to myristicin (Shulgin et al. 1967; Truitt et al. 1961), contributes to the psychotomimetic effect of nutmeg.

It should be emphasized that safrole is a known weak carcinogen (Farnsworth et al. 1976) and that prolonged use of nutmeg or other materials containing safrole could have serious implications.

For hallucinating purposes, ground nutmeg is taken orally in large doses, usually several teaspoonsful. The effects vary appreciably but are often characterized by distortion of perception of time and space, dizziness, tachycardia, dry mouth, headache and occasionally visual hallucinations (Forrest and Heacock 1972; Kalbhen 1971; Weil 1965, 1966, 1967).

Myristicin has been identified as a component of cigarette smoke (Schmeltz et al. 1966).

Myristica is a genus of some 120 species of the Old World tropics. The only commercially important species is *M. fragrans,* native of the Moluccas and source of two products: nutmeg from its seeds, and mace from the aril surrounding the seed.

NITROGENOUS PRINCIPLES

1. β-CARBOLINES

Malpighiaceae

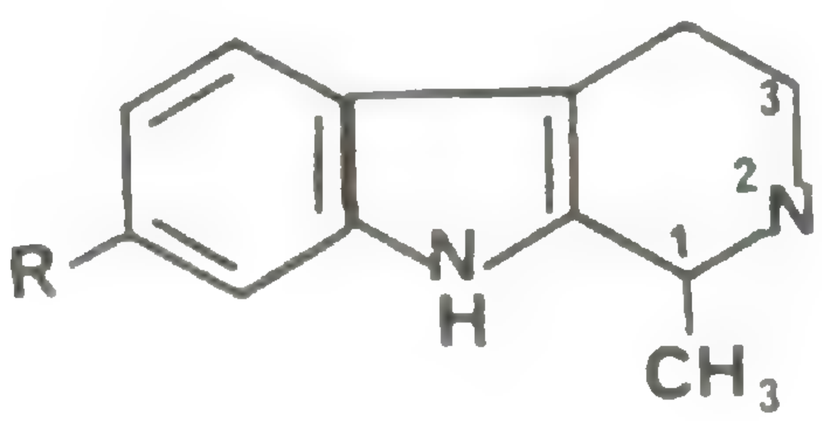
Banisteriopsis C.B. Rob. & Small

In wet tropical forest areas of northern South America, the aborigines use as hallucinogens several species of *Banisteriopsis* containing harmala alkaloids: *B. Caapi* (Spr. ex Griseb.) Mort., *B. inebrians* Mort. An intoxicating drink is prepared from the bark of the stems in the Amazon of Brazil, Bolivia, Colombia, Ecuador and Peru, the Orinoco of Venezuela and the Pacific coast of Colombia. It is variously known as *ayahuasca, caapi, yajé, natema, pindé*, or *dapa.* Usually, only one species enters the preparation, but frequently admixtures of other plants are employed (Friedberg 1965; Rivier and Lindgren 1972; and Schultes 1957, 1961b).

A genus of some 100 species of tropical America, *Banisteriopsis* is taxonomically still rather poorly understood. The classification of *B. Caapi* and *B. inebrians* is particularly confused, primarily because of the sparcity of fertile material for study of these infrequently flowering jungle lianas, even though the earliest botanical attention to this drug plant dates from 1852, when it was first encountered in northwestern Brazil by the explorer Spruce (Schultes 1957, 1966b, 1979a,b).

The chemistry of these hallucinogenic species of *Banisteriopsis* has been more critically investigated than the taxonomy, yet the failure of chemists to insist upon botanically determined and vouchered material for analyses has created chaos. Earlier workers, isolated alkaloidal constituents which they named telepathine, yageine and banisterine from plants referable probably to *B. Caapi.* All of these alkaloids were eventually identified as harmine (VI). More recent examination of botanically authenticated material of this species has established the presence

in the bark—and sometimes in the leaves of harmine as well as occasional lesser amounts of harmaline (VII) and (±)-tetrahydroharmine (VIII) (Chen and Chen 1939; Deulofeu 1967). Investigations of *B. inebrians* in more recent years have yielded harmine from the stems as well as minute amounts of what appears to be harmaline (O'Connell and Lynn 1953). An interesting chemical study of stems of the type collection of *B. Caapi* has indicated, in spite of the passage of some 115 years, the presence of harmine in concentrations matching that of freshly collected material (Schultes et al. 1969). Several new harman-type bases have been reported in *B. Caapi* by Japanese workers, including acetyl norharmine, ketotetrahydronorharmine, harmic amide, harmalinic acid, harmic acid methyl ester and harmine-N-oxide (Hashimoto and Kawanishi 1975, 1976).



	R	Other
VI	OCH_3	Δ^1, Δ^3
VII	OCH_3	Δ^1
VIII	OCH_3	-N-H
IX	H	Δ^1, Δ^3

While *Banisteriopsis Caapi* is normally employed as a drink, recent indirect evidence from the northwest Amazon indicates that it may also be used as a snuff. Harmala alkaloids have been reported from snuff powders prepared from a vine said to be the source of an intoxicating drink, but voucher botanical specimens are lacking (Holmstedt and Lindgren 1967).

Harmine has been isolated from *Cabi paraensis* Ducke of the eastern Amazon. *Cabi* is a genus closely allied to *Banisteriopsis*.

While the plant is valued in folk medicine, it is apparently not employed as an hallucinogen (Schultes 1970c).

Banisteriopsis argentea (Spreng. ex. A. Juss.) Mort., an Indian species, has been shown to contain tetrahydroharman, 5-methoxytetrahydroharman, harmine and harmaline, and a novel related β-carboline, leptaflorine (Ghosal et al. 1971), but this species does not appear to have been used as an hallucinogen.

Solanaceae

Nicotiana L.

It is well established that *tobacco* (*Nicotiana* spp.) has been used for hallucinatory purposes for centuries. Substantive evidence for the effect is lacking, however: the normal *Nicotiana* alkaloids, i.e. nicotine, etc., hardly offer an explanation. Recently, Janiger and Dobkin de Rios (1976) have raised the question as to whether or not the substantial quantities of two well known hallucinogens, i.e. harman (IX) and norharman (10–20 mcg. per cigarette), are absorbed into the blood stream during the smoking process. They also raise the question as to whether the tobacco products used by aborigines, who have been primary users of tobacco products for hallucinogenic purposes, would produce harman and norharman, since their tobacco products would probably have been cured in a different manner than tobacco currently used in western society. These two bases are pyrosynthesized and do not exist as such in normal tobacco. Certainly this challenge should encourage analysis of the blood of tobacco users in an effort to support or deny such an hypothesis (Janiger and Dobkin de Rios 1976).

Zygophyllaceae

Peganum L.

The *Syrian rue* or *Peganum Harmala* L. is an herb found in dry localities from the Mediterranean area east to India, Mongolia and Manchuria. It is a member of a genus of six species distributed in dry areas of Asia Minor and Asia and in southwestern United States and Mexico. Although this and other species of *Peganum* have long been esteemed in folk medicine, its purposeful employment as an hallucinogen is open

to question, vague reports notwithstanding, even though it does have psychotomimetic principles (Porter 1962). It has recently been suggested that the famous soma of ancient India might have been *P. Harmala* (Flattery 1978). The pharmacology of harmine (Beer 1939) and related bases has been reviewed (Naranjo 1967).

The seeds of *Peganum Harmala* contain harmine, harmaline, harmalol, harmol, harman, peganine, isopeganine, dipegine, vasicinone and deoxyvasicinone, bases of a typical β-carboline structure of wide botanical and geographical distribution, having been isolated from at least 27 plant families of both the New and the Old World (Kurbanov and Zharekeev 1974; Mirzakhmedov et al. 1975; Zharekeev et al. 1974).

2. ERGOLINES

Convolvulaceae

Ipomoea L. and *Turbina* Raf.

The early Spanish chroniclers of Mexico reported that the Indians employed in their religious and magic rites an hallucinogenic seed called *ololiuqui* by the Aztecs. It was also used medicinally and was said to have analgesic properties when applied as a poultice.

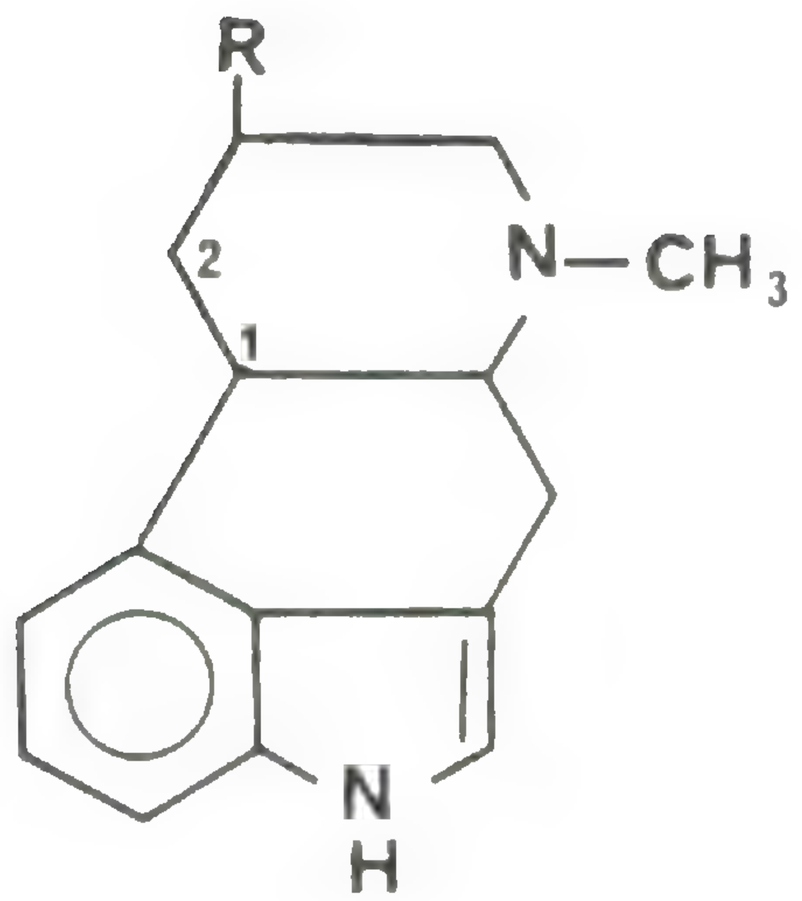
Known as *coatl-xoxouhqui* ("snake plant"), the plant was adequately illustrated as a morning glory. Although several Mexican botanists accepted this identification during the last century, not until 40 years ago was a voucher specimen of a convolvulaceous plant, the seeds of which were employed as a divinatory hallucinogen, collected amongst the Mazatecs of Oaxaca and determined as *Turbina corymbosa* (L.) Raf. (formerly known as *Rivea corymbosa* (L.) Hall. f.). Later, field work uncovered similar uses of another morning glory, *Ipomoea violacea* L., amongst the Zapotecs, also of Oaxaca where it is called *badoh negro;* this species represents possibly the narcotic *tlitliltzin* of the ancient Aztecs (MacDougall 1960a; Schultes and Hofmann 1973, 1980).

In the interval, *ololiuqui* had been identified as a species of *Datura,* an identification that gained wide acceptance (Safford 1916b). The reasoning on which this theory was based held that

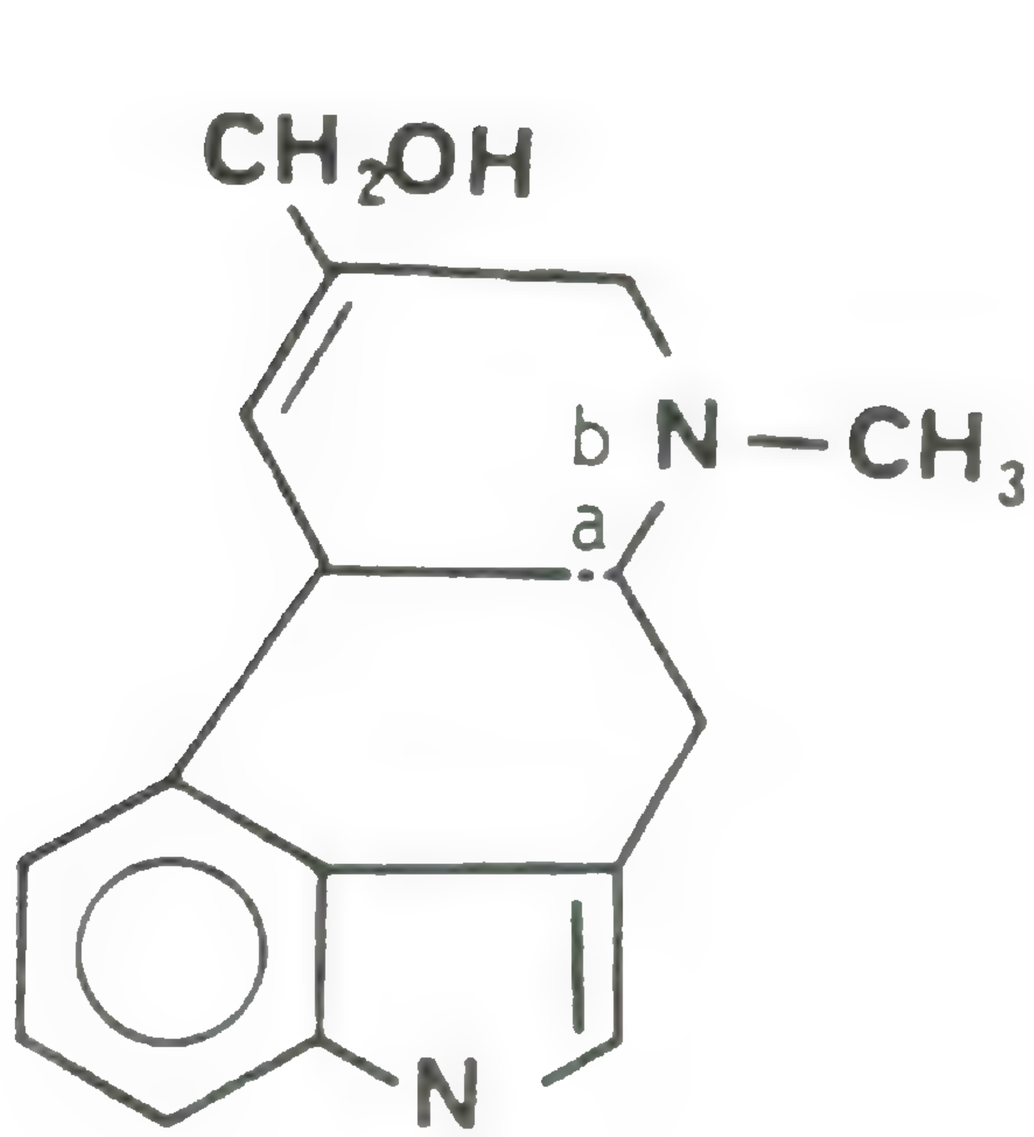
in four centuries no narcotic use had been observed for a morning glory; that the convolvulaceous flowers resembled those of *Datura* and might have led to confusion; and that descriptions of ololiuqui-intoxication coincided closely with that induced by *Datura; Datura* had been and still is employed as a divinatory narcotic in Mexico; and, most significantly, no psychoactive principle was known from the Convolvulaceae.

Experimental psychiatry indicated that *Turbina* was definitely hallucinogenic (Osmond 1955), supporting ethnobotanical field work (Schultes 1970c). Yet chemists were unable to isolate any inebriating constituents until 1960, when ergot alkaloids related to the synthetic hallucinogenic compound LSD were found in the seeds of both *T. corymbosa* and *Ipomoea violacea.*

The main psychotomimetic constituent of the seeds of both species are ergine (*d*-lysergic acid diethylamide) (X) and isoergine (*d*-isolysergic acid diethylamide) (XI) which occur together with minor alkaloids: chanoclavine, (XII), elymoclavine, (XIII), and lysergol (XIV). Ergometrine appears to be present in seeds of *Ipomoea violacea* but absent in *Turbina corymbosa.* The total alkaloid content of *T. corymbosa* seed is 0.012%; of *I. violacea,* 0.06%—and, indeed, Indians use smaller quantities of the latter than of the former (Hofmann 1961, 1963).



	R	Other
X	$-CO-NH_2$	Δ^1
XI	$..CO-NH_2$	Δ^1
XIV	$-CH_2OH$	Δ^2



XII	Seco a,b
XIII	

a. *The Discovery of Ergot Alkaloids.*—Constituents of *ergot, Claviceps purpurea* (Fr.) Tul., a relatively primitive ascomycete, in one of the phylogenetically most advanced angiosperm families was unexpected and is of great chemotaxonomic interest. Suspicion that fungal spores might have contaminated the convolvulaceous seeds was experimentally ruled out (Taber and Heacock 1962), and the discovery of the same alkaloids in fresh leaves, stalks, and root of *Ipomoea violacea* and, to a minor extent, in leaves of *Turbina corymbosa* indicated that these constituents are produced by the tissue of the morning glories themselves, not by infecting fungi (Shinners 1965).

Studies have shown the presence of these ergot alkaloids in a number of horticultural "varieties" of *Ipomoea violacea* and other species of *Ipomoea,* as well as in the related genera *Argyreia* and *Stictocardia* (Chao and Der Marderosian 1973; Der Marderosian and Youngken Jr. 1966; Hylin and Watson 1965; Taber et al. 1963).

There are folklore references to psychotomimetic uses of *Ipomoea carnea* Jacq. in Ecuador, where its common names, *borrachera* and *matacabra,* refer to its inebriating or toxic effects. Ergot alkaloids have been isolated from this species (Lascano et al. 1967; Naranjo, 1969; Naranjo et al. 1964).

The nomenclature and taxonomy of the Convolvulaceae are in a state of extreme confusion, especially as to delimitation of genera (Der Marderosian 1965; Schultes 1970c, 1980; Shinners 1965). *Turbina corymbosa* occurs in the southernmost United States, Mexico and Central America, some of the Caribbean islands and the northern coast of South America. It has at least nine synonyms, of which *Ipomoea sidaefolia* (HBK.) Choisy and *Rivea corymbosa* are the most frequently employed. *Ipomoea,* comprising upwards of 500 species in the warm temperate and tropical parts of the hemisphere, is a genus of climbing herbs or shrubs, rarely semi-aquatic. *Ipomoea violacea,* often referred to by its synonyms *I. rubrocaerulea* Hook. and *I. tricolor* Cav., is represented in horticulture by a number of "varieties", such as Heavenly Blue, Pearly Gates, Flying Saucers, Wedding Bells, Summer Skies, and Blue Stars — all of which contain the hallucinogenic ergot alkaloids (Der Marderosian 1967b).

The hallucinogenic effects of the ergot alkaloids have been known for centuries in Europe. *Claviceps purpurea,* parasitic on rye and other grasses, has long been used medicinally by midwives in cases of difficult childbirth, since ergot acts to induce contractions of involuntary muscle and, as a strong vasoconstrictor, to help reduce postpartem hemorrhage. During the Middle Ages, in rye-consuming areas of Europe, periodic poisoning of whole villages with ergotism occurred. Those who ate rye bread contaminated with ergot frequently suffered gangrene and loss of limbs, hallucinations, permanent insanity, and death. The cause of these epidemics was discovered only during the 17th Century (Schultes and Hofmann 1980).

While ergot has probably never been purposefully used as an hallucinogen in Europe, an interesting hypothesis has been offered that a species of ergot, *Claviceps paspali* (Schw.) Stevens & Hall, may have played a role in the Mysteries of Eleusis in ancient Greece, secret rituals which have long puzzled classical scholars (Wasson, Hofmann and Ruck 1978).

3. IBOGA INDOLES

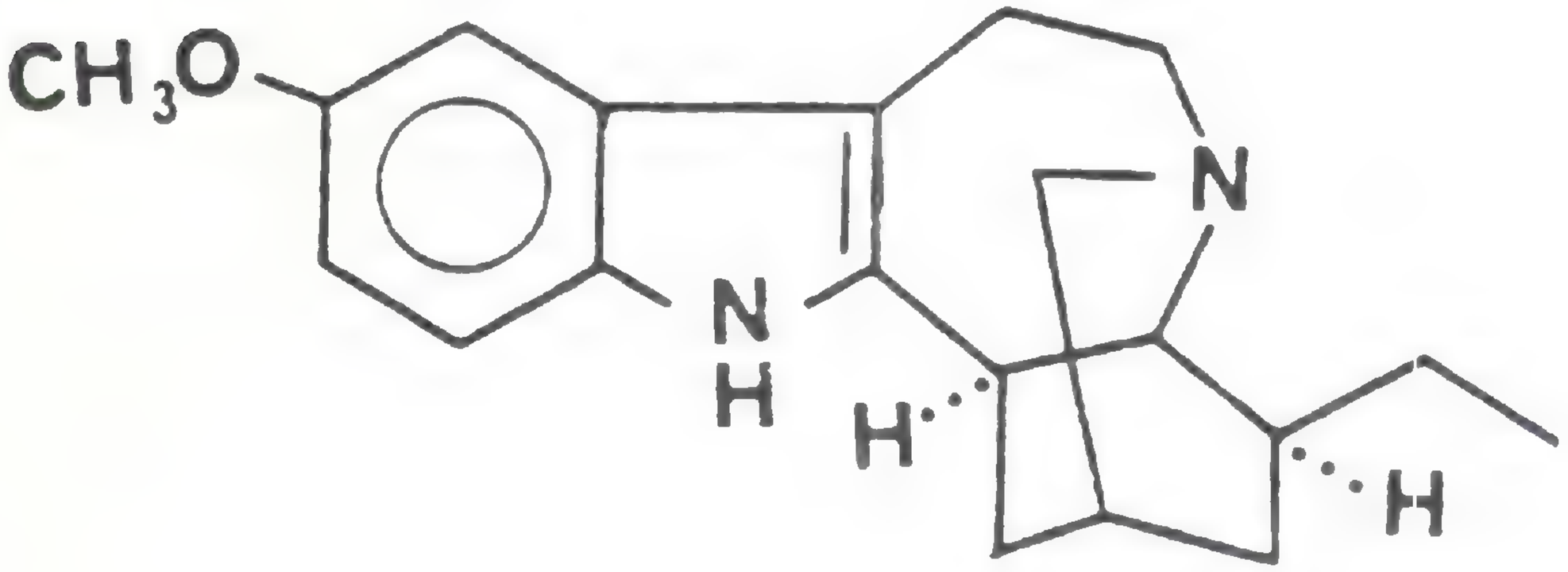
Apocynaceae

Tabernanthe Baill.

Probably the only member of this alkaloid-rich family known definitely to be utilized as an hallucinogen is *iboga,* the yellowish root of *Tabernanthe Iboga* Baill. This narcotic is of great social importance, especially in Gabon and nearby portions of the Congo in Africa. The religious use of iboga, early reported by French and Belgian explorers in the middle of the last century, appears to be spreading. In Gabon, it is employed in initiation rites of secret societies, the most famous of which is the Bwiti Cult. Sorcerers take the drug before communicating with the spirit world or seeking advice from ancestors (Fernandez 1972; Pope 1969).

Twelve closely related indole alkaloids have been reported from iboga; they comprise up to 6% of the dried roots. Ibogaine (XV), apparently the principal psychoactive alkaloid, acts as a cholinesterase inhibitor, a strong central stimulant and as an hallucinogen (Dybowski and Landrin 1901; Haller and Heckel

1901; Hoffer and Osmund 1967; Pope 1969; Schneider and Sigg 1957).



XV

Tabernanthe is a genus of about seven species native to tropical Africa.

Sometimes other plants — occasionally as many as 10—are taken with *iboga,* but few have been botanically identified or chemically investigated. One of the most interesting, the euphorbiaceous *Alchornea floribunda* Muell.-Arg., is employed in the same way as iboga in another secret society in Gabon, but it may not be hallucinogenic. Its active principle has been thought to be the indole yohimbine (Fernandez 1972; Schultes 1970c), an unusual taxonomic occurrence for this base; recently, alchorneine, isoalchorneine and alchorneinone have been reported from this species (Khuong-Huu, Le Forestier and Goutarel 1972)

4. ISOXAZOLES

Agaricaceae

Amanita L.

Amanita muscaria (L. ex Fr.) Pers. ex W.J. Hook.—the *fly agaric,* a mushroom of the north-temperate zone of Eurasia and

North America—may represent one of the oldest of the hallucinogens used by man, and only very recently has a clarification of the chemistry of its active principles begun to take shape (Eugster 1967; Heim 1963b).

The Aryan invaders of India 3500 years ago worshipped a plant, the god-narcotic *soma,* centre of an elaborate cult in which the inebriating juice was ceremonially drunk (Wasson 1968). More than 1000 hymns to *soma* have survived in the Rig Veda, describing the plant and its significance in detail. The use of soma died out 2000 years ago. Botanists have proposed more than 100 species in attempts to identify soma, but none have been satisfactory. The most recent identification of soma as *Amanita muscaria* appears, from the indirect evidence at hand, to be highly probable.

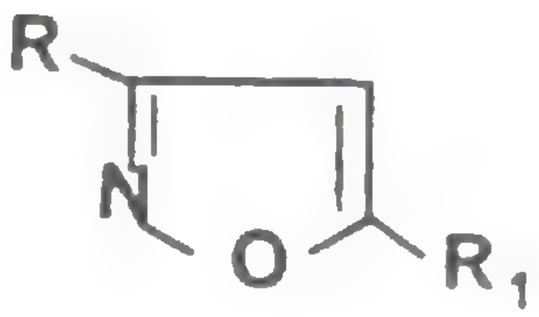
In the 18th Century, Europeans discovered the narcotic use of *Amanita muscaria* among primitive tribesmen of Siberia. Until very recently, it was employed as an orgiastic or shamanistic inebriant by the Ostyak and Vogul, Finno-Ugrian peoples in western Siberia, and the Chukchi, Koryak and Kamchadal of northeastern Siberia. Tradition has established its use amongst other peoples (Wasson 1967, 1968).

In Siberia, several mushrooms sufficed to induce intoxication –taken as extracts in water or milk, alone or with the juice of *Vaccinium uliginosum* L. or *Epilobium angustifolium* L. A dried mushroom may be held moistened in the mouth, or women may chew the mushrooms and roll them into pellets for the men to ingest. Since the mushrooms often were expensive, the Siberians practiced ritualistic drinking of the urine of an intoxicated person, having discovered that the inebriating principles were excreted unaltered by the kidneys. Urine-drinking is mentioned in the Rig Veda hymns to *soma* (Wasson 1968).

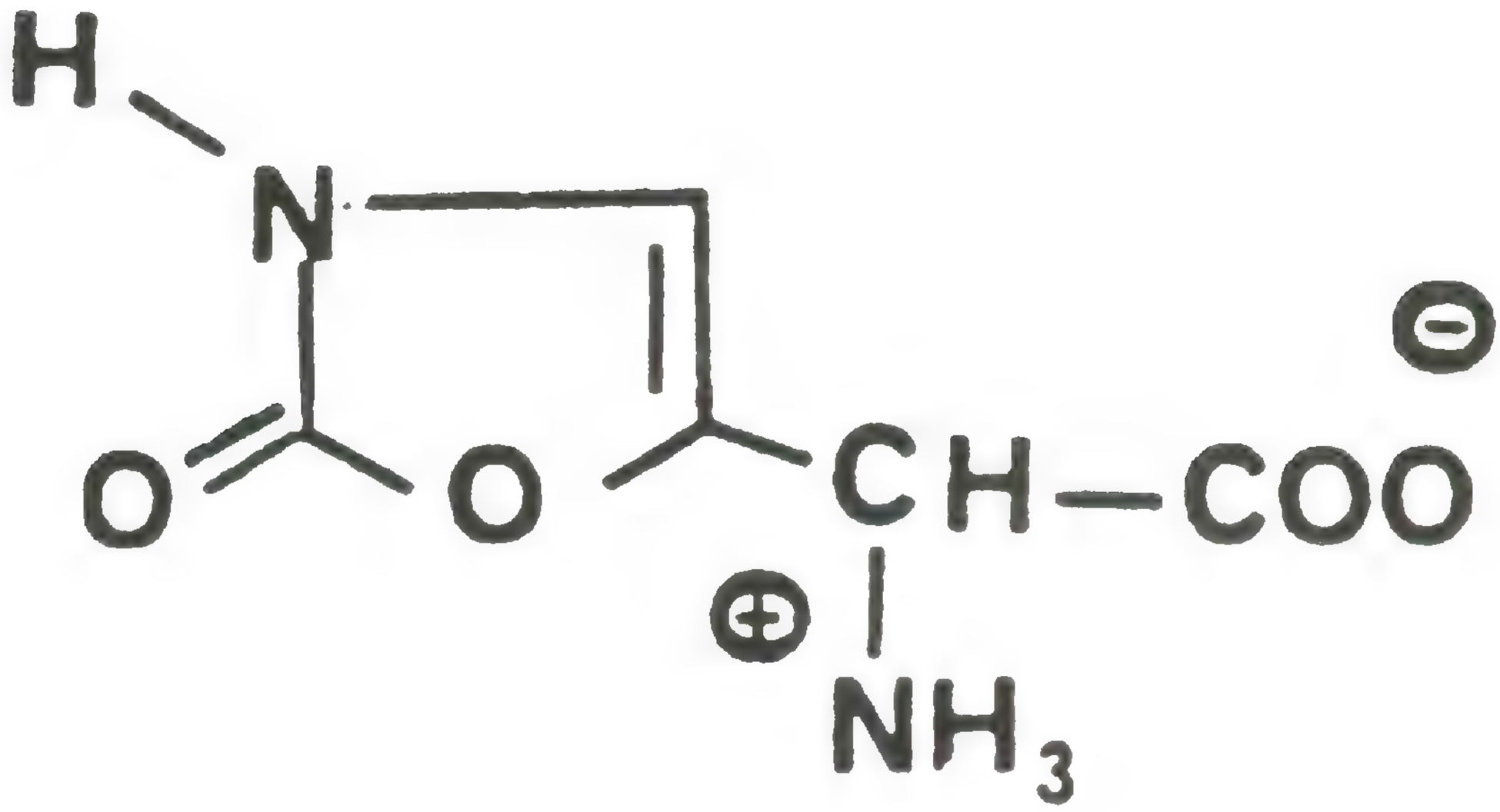
There is indirect evidence suggesting that *Amanita muscaria* may have been used in Middle America. The ceremonial use of the fly agaric has been recently discovered amongst the Ojibway Indians of the United States (Wasson, pers. commun.), and unconfirmed indications of its use in northwestern Canada have recently been indicated (Halifax, pers. comm.).

Since the discovery in 1869 of muscarine, the intoxicating activity of *Amanita muscaria* has been attributed to this alkaloid. Recent studies, however, have indicated that muscarine represents a very minor constituent of the mushroom to which the strong inebriation could hardly be attributed. Trace amounts of bufotenine in the carpophores, likewise, could not be responsible, if indeed it be present. The reported presence of tropane alkaloids has been shown to be due to incorrect interpretation of chromatographic data. Other compounds detected in *A. muscaria* are choline, acetylcholine and muscaridine (Eugster 1965; Wasser 1967; Wasson 1967).

Recent chemical and pharmacological studies have shown that the principal biologically active constituents appear to be muscimol (XVI), the enolbetaine of 5-aminoethyl-3-hydroxyisoxazole—an unsaturated cyclic hydroxamic acid which is excreted in the urine; and ibotenic acid (XVII), the zwitterion of α-amino-α-3-hydroxyisoxazolyl-5-acetic acid monohydrate. The less active muscazone (XVIII), likewise an amino acid [α-amino-α-2(3H)-oxazolonyl-5-acetic acid] is present in varying but lesser amounts. Structurally related to these isoxazoles is the antibiotic oxamycin, which often has psychoactive side effects in man: mental confusion, psychotic depression, abnormal behavior. Other active substances, still not structurally elucidated, are also known to be present (Eugster 1967; Hatfield et al. 1975; Wasser 1967).



	R	R_1
XVI	$-O^-$	$-CH_2-NH_3^+$
XVII	$-OH$	$-CH(^+NH_3)-COO^-$



XVIII

Widely recognized variability in the psychoactivity of *Amanita muscaria* results probably from varying ratios of ibotenic acid and muscimol in the carpophores. In spite of appreciable variability between individuals, certain effects are characteristic: twitching of the limbs, a period of good humour and euphoria, macropsia, occasionally colored visions of the supernatural and illusions of grandeur. Religious overtones frequently occur, and the user may become violent, dashing madly about, until exhaustion and deep sleep overtake him.

In a recent interesting account, Ott has described in some detail the current social use of Amanitas in the United States (Ott 1978).

The genus *Amanita,* comprising from 50 to 60 species, is cosmopolitan, occurring on all continents except South America and Australia, but the species occupy definitive areas. *Amanita muscaria* has recently been found growing in large colonies near Medellín, Colombia, but it appears to have been introduced, perhaps with pines for reforestation. A number of the species are toxic, and their chemical constitution, still poorly understood, seems to be variable.

5. β-PHENYLETHYLAMINES

Cactaceae

Lophophora Coult.

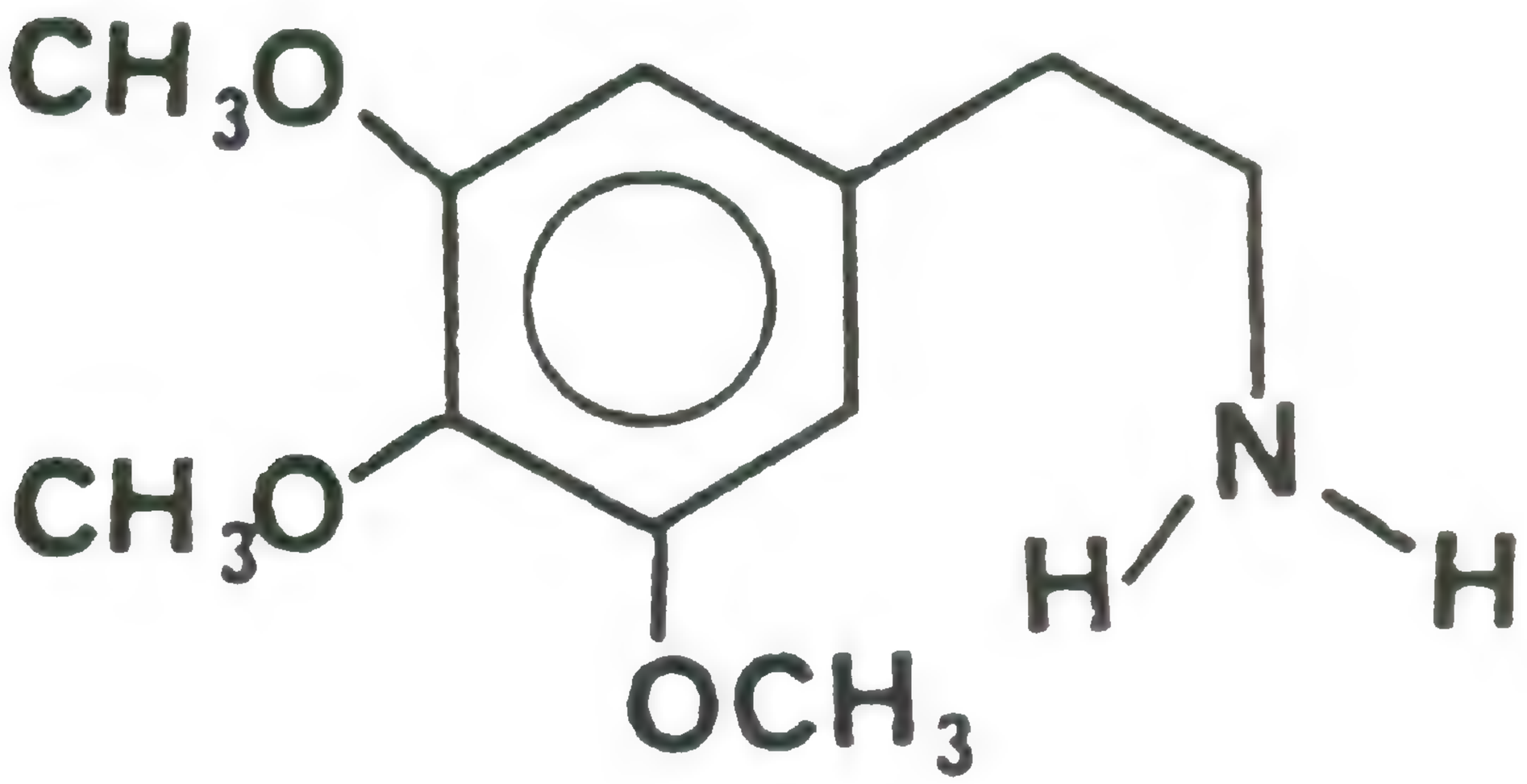
One of the ancient sacred hallucinogens of Mexico, still in use, is the small, grey-green, napiform, spineless cactus *peyote: Lophophora Williamsii* (Lem.) Coult. It might well be called the "prototype" of hallucinogens, since it has been one of the most spectacular and most thoroughly studied psychotomimetics known. It was first fully described by the early Spanish medical doctor Francisco Hernandez, but many other colonial Spanish chroniclers detailed the strange story of peyote. Peyote rites persist in several tribes of northern Mexico. It was used in Texas in 1760, was known amongst American Indians during the Civil War but came to public attention in the United States about 1880, when the Kiowas and Comanches elaborated a typical Plains Indian vision-quest ritual around its ceremonial ingestion. The Peyote Cult, organized as the Native American Church, has gradually spread to many tribes in the United States and Canada and counts at least 250,000 adherents (Collier 1952; LaBarre 1959, 1960; Schultes 1937a, 1937b and 1937c). The chlorophyll-bearing crown of the cactus is eaten. It can be dried into discoidal "mescal buttons", which are virtually indestructible and can be shipped over long distances.

The peyote cactus was first botanically described as *Echinocactus Williamsii* Lem. in 1845. In the chemical literature, it is still frequently referred to this genus and to *Anhalonium* Lem. In 1894, it was placed in the genus *Lophophora.* Its nomenclature and taxonomy are still confused, and *L. Williamsii* has more than 25 synonyms, most of them referring to age-forms of the variable crown (Anderson 1980; Schultes 1937a). *Lophophora* was once accepted as monotypic. Recent work, however, indicates that *L. diffusa* (Croiz.) Bravo of Querétaro, Mexico, is morphologically and chemically worthy of specific recognition (Bruhn 1975b, 1976).

Lophophora is placed in the tribe *Cereae,* subtribe *Echinocactanae,* a subtribe of some 28 genera, many of them small or monotypic and included in *Echinocactus* Link, (*Ariocarpus* Scheidw., *Astrophytum* Lem., *Roseocactus* Berger, etc.). It

occurs in central Mexico and near the Rio Grande in southern Texas.

More than 30 alkaloids and their amine derivatives have been isolated from *Lophophora Williamsii,* belonging mainly to the β-phenylethylamines and the biogenetically related simple isoquinolines (Kapadia and Fayez 1970). The β-phenylethylamine mescaline (XIX) is exclusively responsible for the visual hallucinations; its derivatives, N-methylmescaline and N-acetylmescaline, are apparently not active. Hordenine, another β-phenylethylamine, is also present in peyote. Peyonine, a novel β-phenylethylpyrrole, was recently isolated from this cactus, pharmacology of this derivative of mescaline, or its precursors, has not yet been reported (Agurell 1969; Reti 1950). Mescaline has been reported in *Lophophora diffusa* (Bruhn and Holmstedt 1974).



XIX

Ariocarpus Scheidw.

N-methyltyramine, 3,4-dimethoxy-N-methylphenylethylamine and 3,4-dimethoxy-N,N-dimethylphenylethylamine, are reported in *Ariocarpus scapharostrus* Boedeker (Bruhn 1975a). Several species of *Ariocarpus*—*A. fissuratus* (Engelm.) Schum. and *A. retusus* Scheidw.—are known as false peyotes and may oc-

casionally be employed in northern Mexico in magic and witchcraft (Schultes and Hofmann 1973, 1979 and 1980).

Opuntia Mill.

Opuntia cylindrica (Lam.) DC. contains 0.9 percent mescaline (Turner and Heyman 1960) and *O. spinosior* (Engelm.) Toumey contains 0.00004% of the same alkaloid (Kruger et al. 1977; Pardanani et al. 1978).

Pelecyphora Ehrenb.

The Mexican cactus *Pelecyphora aselliformis* Ehrenb. is reported to contain mescaline (Díaz 1977, 1979).

Trichocereus (Berger) Riccob.

Several species of the South American genus *Trichocereus* have yielded mescaline: *T. macrogonus* (Salm-Dyek) Riccob. *T. Pachanoi* Britton & Rose, *T. Terscheckii* (Parment.) Britt. & Rose, *T. Werdermannianus* Backeb. (Agurell 1969; Vanderveen et al. 1974); and *T. peruvianus* Britt. & Rose (Pardanani et al. 1977). The large columnar *T. Pachanoi* of the dry Andes--called *San Pedro* in Peru and *aguacolla* in Ecuador—is employed in magic and folk medicine in northern Peru (Poisson 1960). Together with another cactus, *Neoraimondia macrostibas* (Schum.) Britton & Rose, and *Isotoma longiflora* Pres., *Pedilanthus tithymaloides* Poit. and a species of *Brugmansia,* it is the base of an hallucinogenic drink called *cimora* (Schultes 1970c).

There are some 40 species of *Trichocereus* known from subtropical and temperate South America.

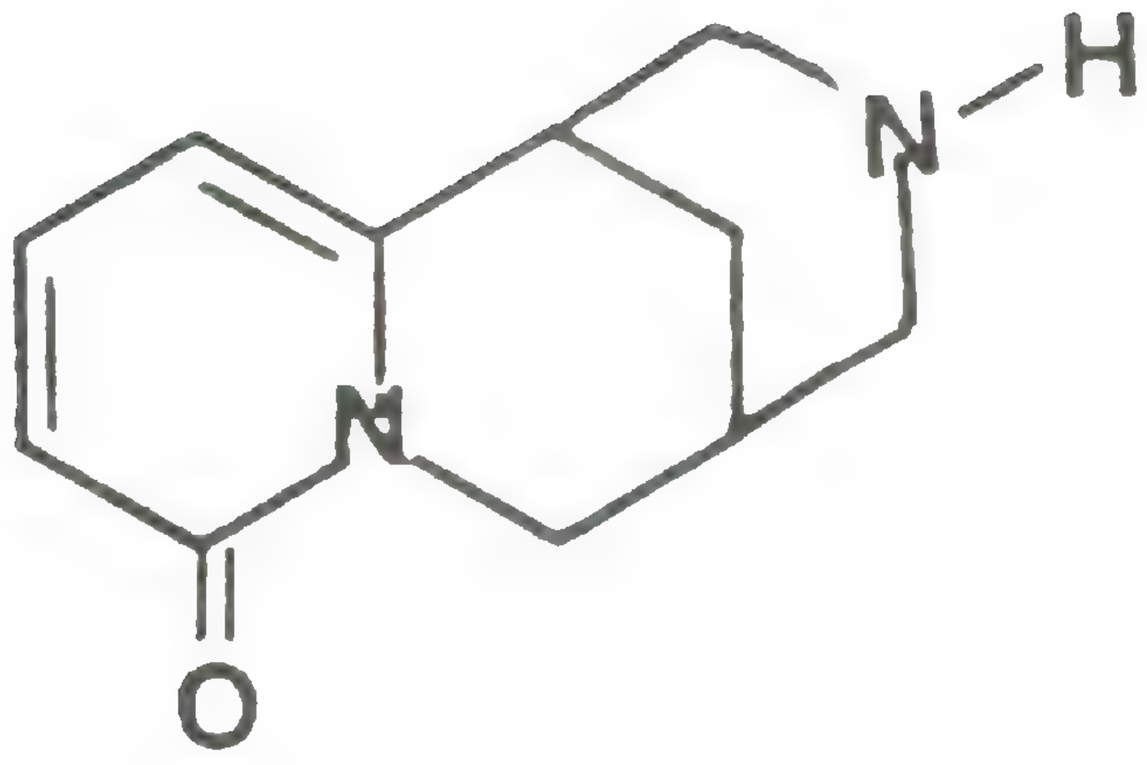
6. QUINOLIZIDINES

Leguminosae

Cytisus L.

The hallucinogenic use by Yaqui medicine men in northern Mexico of *Cytisus (Genista) canariensis* (L.) O.Ktze., a shrub native to the Canary Islands, not to Mexico, has been documented (Fadiman 1965). It is rich in the alkaloid cytisine (ulexine, baptitoxine, sophorine) (XX) which occurs commonly in the Leguminosae (Willaman and Schubert 1961).

About 25 species of *Cytisus.* native to the Atlantic Islands, Europe, and the Mediterranean area, are known, and a number of the species are toxic.



XX

Sophora L.

A shrub of dry areas of the American Southwest and adjacent Mexico, *Sophora secundiflora* (Ort.) Lag. ex DC. yields the so-called *mescal beans* or *red beans.* Mexican and Texan Indians formerly employed these beans in the ceremonial Red Bean Dance as an oracular and divinatory medium and for visions in initiation rites (LaBarre 1959; Schultes 1937a). Its use died out in the United States with the arrival of peyote, a much safer hallucinogen. Mescal beans, which contain cytisine, (Izaddoost 1975; Keller 1975), are capable of causing death by asphyxiation (Howard 1957). The pharmacology of cytisine has been reported (Zachowski 1938). Historical reports of the mescal bean go back to 1539, but archaeological remains suggest their ritualistic use earlier than 1000 A.D. (Adovasio and Fry 1976; Campbell 1958).

Sophora, with some 50 species, occurs in tropical and warm temperate parts of both hemispheres.

Lythraceae

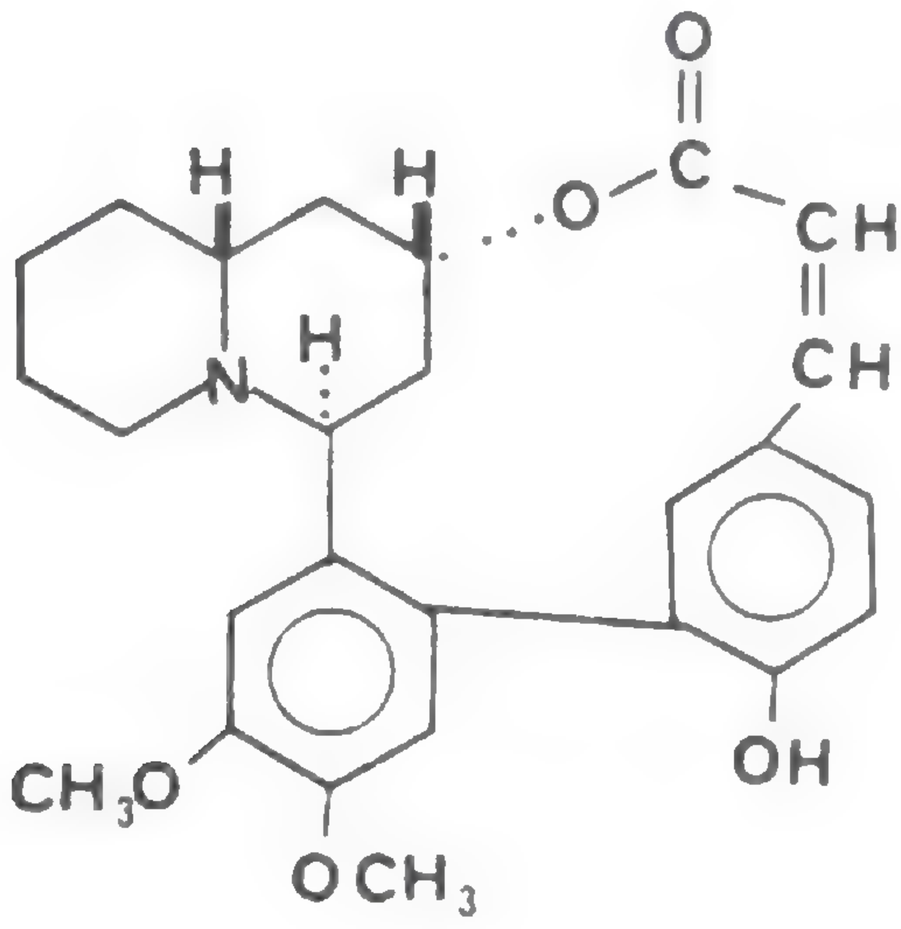
Heimia Link & Otto

Heimia salicifolia (HBK.) Link & Otto has been valued in Mexican folk medicine since early times. Known as *sinicuichi,* its leaves are wilted, crushed in water, and the juice set in the sun to ferment. The resulting drink is mildly intoxicating. Usually devoid of unpleasant after effects, it induces euphoria characterized by drowsiness, a sense of shrinkage of the surroundings,

auditory hallucinations and a general removal from a sense of reality (Robichaud et al. 1964, 1965).

Alkaloids were first reported from *Heimia salicifolia* in 1964; the major psychoactive one appears to be cryogenine (vertine) (XXI) (Blomster et al. 1964; Douglas et al. 1964; Kaplan and Malone 1966; Robichaud et al. 1964, 1965). Differing from the usual quinolizidines in having the quinolizidine as part of a larger system of rings, cryogenine has been found only in the Lythraceae.

The genus *Heimia* comprises three hardly distinguishable species and ranges from southern United States to Argentina.



XXI

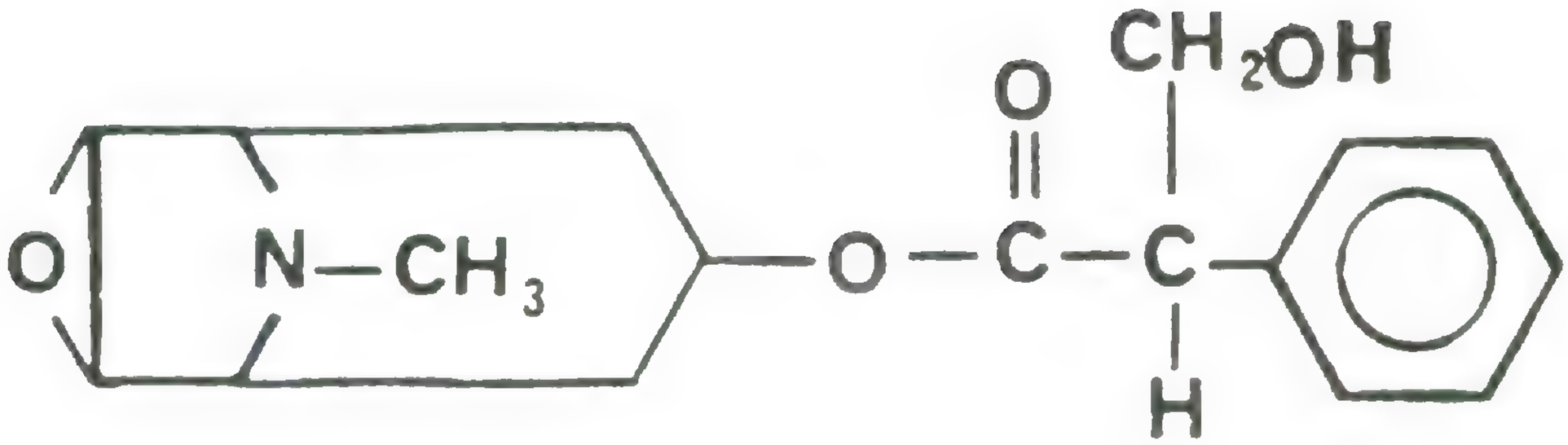
7. TROPANES

Solanaceae

Atropa L.

The *belladonna* or *deadly nightshade,* (*Atropa Belladonna* L.) was utilized as an hallucinogen in Europe in medieval witches' brews. Its principal active constituent has long been known to be scopolamine (XXII); additional minor tropane alkaloids are also present (Wagner 1969).

There are four species of *Atropa,* distributed in Europe, the Mediterranean area, and from Central Asia to the Himalayas.



XXII

Brugmansia Pers.

Usually considered to represent a subgenus or section of *Datura* L., *Brugmansia* has recently been shown conclusively on biological as well as morphological characters to deserve distinction as a genus (Lockwood 1973). Native to South America, the nine species are arborescent. All appear to be cultigens unknown in the truly wild state (Lockwood 1979).

The most widespread species, *Brugmansia aurea* Lagerh., occurs throughout the Andes from Colombia to northern Chile at elevations of 8,000 to 10,000 feet. Another striking species, *B. sanguinea* (R. & P.) D. Don is native from Colombia to Peru. Most of the species were of the greatest social and religious importance in ancient Andean cultures (Lockwood 1979). The Chibchas of Colombia, for example, administered potions of *B. aurea* to wives and slaves of deceased chieftains to induce a stupour prior to their being buried alive with the departed master. *B. sanguinea* was a sacred ceremonial plant in the Temple of the Sun in Sogamosa, in northern Colombia, where its psychoactive properties must have had a role in religious rites.

Modern Indians of Colombia, Ecuador and Peru still use species of *Brugmansia* in magico-religious and medicinal rites. The Mapuche of Chile use it as correctional medicine for recalcitrant children, believing that the spirit of ancestors admonish the youths through the hallucinations. In modern Peru, Indians still believe that *B. sanguinea* permits them to communicate with ancestors and that, through visual hallucinations, it can reveal treasures preserved in graves or "huacas"—the reason for its local name *huacacachu* ("grave plant").

The drug is most commonly taken in the form of powdered seeds added to fermented drinks or as a tea of the leaves. A dangerous hallucinogen, *Brugmansia* brings on an intoxication often so violent that physical restraint is necessary before the onset of a deep stupor, during which the visions are experienced.

The species currently recognized are *Brugmansia arborea,* (L.) Lagerh., *B. aurea, B.* x *candida* Pers., B. x *dolichocarpa* Lagerh., *B.* x *insignis* (B. Rodr) Lockwood, *B. sanguinea,* B. *suaveolens* (H. & B. ex Willd.) Bercht. & Presl, *B. versicolor* Lagerh. and *B. vulcanicola* (A.S. Barclay) R.E. Schult. (Schultes and Hofman, 1980).

The most intensive use of *Brugmansia* appears to be in Sibundoy in southern Colombia, where Kamsá and Ingano medicine men preserve, through vegetative reproduction, highly atrophied clones for which they have native names. These monstrosities — possibly mutants induced by viral infection — vary in narcotic strength and are, consequently, used for different purposes (Bristol 1966, 1969; Lockwood 1973; Schultes and Hofmann 1979b).

What may possibly represent an extreme variant of an indeterminate species of *Brugmansia* has been described as a distinct genus: *Methysticodendron* R.E. Schult. Native to the high, isolated Valley of Sibundoy, *M. Amesianum* R.E. Schult. is important amongst the Kamsá and Ingano as an hallucinogen and medicine, where it is called *culebra borrachera* ("intoxicant of the snake") (Schultes, 1955).

The chemical constitution of *Brugmansia* is similar to that of *Datura,* with tropane alkaloids the active principles. In *B. aurea* from the Andes, scopolamine constitutes from 50-60% of the total alkaloid content, as contrasted with 30-34% for the same plant grown in England and Hawaii. Aerial portions of *B. aurea,* originally from the Colombian Andes, but cultivated in England, contain scopolamine, norscopolamine, atropine, meteloidine and noratropine; roots have the same alkaloids, as well as 3α6β-ditigloyloxytropane-7β-ol, 3α-tigloyloxytropane and tropine. Leaves of the same stock grown in Hawaii contain the identical spectrum of alkaloids but vary in total content and amount of scopolamine (Bristol et al. 1969). The leaves and stems of *Methysticodendron Amesianum* contain scopolamine,

up to 80% of the total alkaloid content (Pachter and Hopkinson 1960).

Significantly, the alkaloid content in the Sibundoy cultivars of *Brugmansia aurea* correlate closely with reports of their relative toxicity by the Indians of Sibundoy. Notwithstanding the great age of their hallucinogenic and medicinal usage, Brugmansias are still the subject of much botanical, ethnobotanical and phytochemical interest.

Datura L.

Datura has a long history an an hallucinogenic genus in both hemispheres (Hoffman 1968; Lewin 1927; Safford 1920, 1921; Schultes; Schultes and Hofmann 1979). The most intense use and the greatest concentration of species occurs in the American Southwest and adjacent Mexico, where four closely related species are known: *D. inoxia* Mill. (more commonly known as *D. meteloides* DC.), *D. pruinosa* Greenm., *D. quercifolia* HBK. and *D. Wrightii* Regel. *Datura Stramonium* L. is now generally believed to be of New World origin and appears to be the species formerly employed by the natives of eastern North America.

There exists in Mexico an anomalous aquatic species, *Datura ceratocaula* Ort. which is so distinct that it is accommodated in a separate section of the genus. It was one of the most sacred hallucinogens of the Aztecs, who knew it as "sister of ololiuqui" (*ololiuqui* = the highly sacred morning glory, *Turbina corymbosa*). Modern Mexican Indians still revere it and call it *torna-loco* ("maddening plant") (Schultes and Hofmann 1973). The most commonly employed species is *D. inoxia,* known today in Mexico as *toloache;* by the Aztecs as *toloatzín.* Many tribes in Mexico and the Southwest still value it as a magic plant. The Zuni use it as an hallucinogen and analgesic; the plant belongs to the rain priests who alone may collect it. They commune at night with the feathered kingdom to intercede with the gods for rain, putting the powdered root into the eyes. The Yuman take it to induce dreams and gain occult powers and predict the future. Yokut boys, at initiation, take it once in a lifetime, but youths studying to be shamans must use it once a year. The Tarahumara add *D. inoxia* to tesguino, a fermented magic drink, to make it stronger; they also take a drink prepared

from the seeds and leaves ceremonially to induce visions. Amongst some Mexican Indians, *toloache* is considered an hallucinogen inhabited, unlike peyote, by a malevolent spirit (Hoffman, 1968).

In the Old World, *Datura* never was used so ceremonially as in the New World. The most important species in the Eastern Hemisphere is *D. Metel* L. mentioned as a drug called *jouzma-thel* in the 11th Century by the Arabian physician Avicenna. In China, it was considered sacred: when Buddha preached, heaven sprinkled the plant with drops of dew or rain. Today, *Datura* seeds are frequently mixed with tobacco or *Cannabis* to be smoked. A less important Old World species, *D. ferox* L., is widely employed in parts of Africa (Safford 1920, 1921).

The active principles of all species of *Datura* are tropane alkaloids. They vary in relative concentrations from species to species. *D. Stramonium* seeds, for example, contain about 0.4% of alkaloid, consisting mainly of hyoscyamine with a small amount of scopolamine and minute amounts of atropine (Claus and Tyler 1967). In *D. Metel,* the following total alkaloids are reported: in fruits, 0.12%; leaves 0.2–0.5%; roots 0.1–0.2%; seeds 0.2–0.5%; the main component is scopolamine, with the minor alkaloids meteloidine, hyoscyamine, norhyoscyamine, norscopolamine, as well as two alkaloids not belonging to the tropane group—cuscohygrine and nicotine (Schultes and Hofmann 1973).

Hyoscyamus L.

Henbane, a toxic species of the genus, is *Hyoscyamus niger* L. and was once widely cultivated in Europe as a narcotic. It entered medieval witches' brews as an hallucinogenic ingredient (Schultes and Hofmann 1979). The psychoactive effects of henbane are attributed mainly to scopolamine (Wagner 1969).

Hyoscyamus comprises about 20 species of Europe, northern Africa and southwestern and central Asia.

Latua Phil.

A century ago, a spiny shrub of Chile, now known botanically as *Latua pubiflora* (Griseb.) Baill., the only member of an endemic genus, was identified as a virulent poison, inducing delirium and visual hallucinations. It was employed by local

Indians, who knew the shrub as *latué* or *arbol de los brujos,* to cause permanent insanity (Murillo 1889). Recent phytochemical studies indicate the presence of atropine and scopolamine (Bodendorf and Kummer 1962; Plowman et al. 1971; Silva and Mancinelli 1959; Schultes 1979).

Mandragora L.

The famed mandrake of Europe, *Mandragora officinarum* L., owes the fame that it has acquired mainly to its hallucinogenic toxicity. The active principles are tropane alkaloids, primarily hyoscyamine, scopolamine, and mandragorine (Staud 1962; Schultes and Hofmann 1979; Wagner 1969).

Six species of *Mandragora* are known, native to the region from the Mediterranean to the Himalayas.

Solandra Sw.

In parts of Mexico, several species of the solanaceous *Solandra*—*S. guerrenensis* Martínez and S. *brevicalyx* Standl.—are employed as sacred hallucinogens. The Aztec names of the former species are *hueipatl* and *tecomaxochitl;* amongst the Huichols, the latter is known as *kieli* and represents a god-plant (Knab 1977). A tea is made from the juice of the branches.

Much remains to be done before the chemistry of *Solandra* is fully understood. Small amounts of atropine, noratropine, (—)-hyoscyamine and norhyoscyamine (Raffauf 1970) as well as tropine, nortropine, cuscohygrine and other bases (Evans et al. 1972) are found.

It is possible that *Solandra guttata* D. Don and *S. nitida* Zucc. are similarly used in Mexico (Schultes and Hofmann 1980).

Solandra is a genus of about 10 species native to Mexico and tropical America. It is closely allied to *Datura* and *Brugmansia.*

8. TRYPTAMINES

Acanthaceae

Justicia L.

The Waikas of the Orinoco headwaters in Venezuela and in northwestern Brazil, occasionally dry and pulverize the leaves of *Justicia pectoralis* Jacq. var. *stenophylla* Leonard as an admixture to their *Virola*-snuff (Carias-Brewer and Steyermark 1976; Schultes 1967; and Schultes and Holmstedt 1968).

There are suspicions that this aromatic herb may contain tryptamines (Holmstedt, pers. comm.) and the plant may on occasion be the basis, without admixtures, of an hallucinogenic snuff (Chagnon et al. 1971). If the preliminary indications can be verified, it will for the first time establish the presence of these indoles in the Acanthaceae.

There are more than 300 species of *Justicia* in the tropical and subtropical parts of both hemispheres.

Agaricaceae

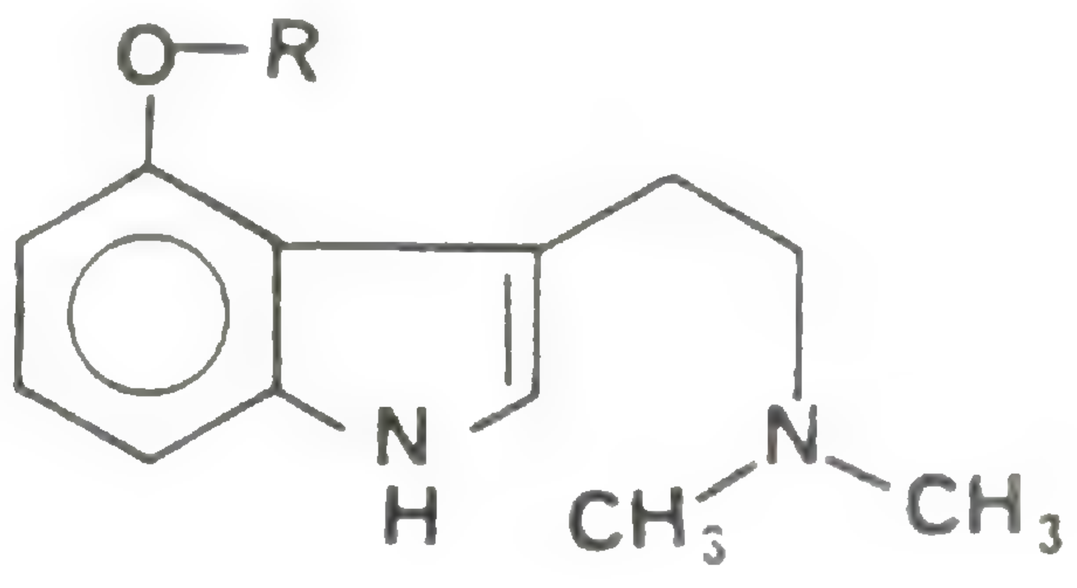
Conocybe, Fayod; *Panaeolus,* (Fr.) Quélet; *Psilocybe* (Fr.) Quélet; and *Stropharia* (Fr.) Quélet

The Spanish conquerors found Mexican Indians practicing religious rites in which mushrooms were ingested as a sacrament, permitting them to commune through hallucinations with the spirit world. The Aztecs knew these "sacred" mushrooms as *teonanacatl* ("food of the gods") (Heim and Wasson 1959; La Barre 1959; Ott and Bigwood 1978; Safford 1915; Schultes 1939).

Persecution by the Roman church drove the cult into hiding in the hinterlands. Notwithstanding many descriptions in the writings of the early chroniclers, no evidence that the narcotic use of mushrooms had persisted was uncovered until about 40 years ago. Botanists had even postulated that *teonanacatl* might be the same plant as peyote: that the discoidal crown of the cactus, when dried, superficially resembled a dried mushroom and that the earlier writers had confused the two or had been deliberately duped by their Aztec informants (Safford 1916b). Then, in the late 1930s, several investigators found an active mushroom cult amongst the Mazatecs in Oaxaca and collected, as the hallucinogenic fungi, *Panaeolus sphinctrinus* (Fr.) Quél. and *Stropharia cubensis* Earle. More intensive work during the 1950's brought to over 24 species, in at least four genera, the number of basidiomycetes employed currently in six or more tribes of Mexican Indians (Guzmán 1959; Heim 1956a, 1956b, 1957a, 1957b, 1963a; Schultes 1939; Schultes and Hofmann 1973; Singer 1958; Wasson 1958; Wasson and Wasson 1957; Ott and Bigwood 1978).

It now appears that the mushroom cults are of great age and were once much more widespread. Archeological artefacts, now called "mushroom stones," excavated in great numbers from highland Mayan sites in Guatemala, are dated conservatively at 1000 B.C. Consisting of a stem with a human or animal face and crowned with an umbrella-like top, these icons indicate the existence of a sophisticated mushroom cult at least 3000 years ago (Schultes and Hofmann 1979).

Perhaps the most important species employed in Mexican mushroom rites are *Psilocybe aztecorum* Heim, *P. caerulescens, P. mexicana* Heim, *P. zapotecorum* Heim, and *Stropharia cubensis* (Heim and Wasson 1959; Heim 1967). All of these have been found to contain a most extraordinarily psychoactive compound, psilocybin (XXIII)—an hydroxyindole alkylamine with a phosphorylic ester group: 4-phosphoryloxy-N,N-dimethyltryptamine, and sometimes the unstable derivative, psilocin (XXIV): 4-hydroxy-N,N-dimethyltryptamine. Psilocybin is the only indole compound known from the Plant Kingdom with a phosphoric acid radical and both psilocybin and psilocin are novel among indoles in having the hydroxy radical substituted in the 4-position (Schultes 1976a; Schultes and Hofmann 1979). Tryptophan is probably the biogenetic precursor of psilocybin (Hofmann et al. 1958, 1959; Hofmann and Troxier 1959; Hofmann and Tscherter 1960).



	R
XXIII	PO_3H^-
XXIV	H

The hallucinogenic activity of psilocin and psilocybin has been reported and reviewed (Cerletti 1959; Isbell 1959; and Weidmann et al. 1958).

These two indoles may occur widely in *Psilocybe* and related genera.

One or both have been isolated from a large number of mushrooms from North and South America, Europe and Asia: from numerous species of Psilocybe (Repke et al. 1977a; Ott and Guzmán 1976; Semerdzieva and Nerud 1973); from Concoybe (Repke et al. 1977a); from Copelandia (Benedict et al 1962, 1967); from six species of Gymnopilus (Hatfield et al. 1978); from Psathyrella (Ott and Guzmán 1976); and from several species of Panaeolus (Repke et al. 1977a; Rubbers et al. 1969).

The occurrence of 4-substituted tryptamines (psilocybin or psilocin) has been reported from *Panaeolus sphinctrinus,* and this psychoactive mushroom also contains 5-hydroxytryptamine and 5-hydroxytryptophan; the closely related *Panaeolus campanulatus* apparently does not contain the hallucinogenic constituents (Tyler and Malone 1960).

Early missionaries in Amazonian Peru reported that the Yurimagua Indians employed an intoxicating beverage made from a "tree fungus" (Schultes 1966a). Although no modern evidence points to the use of an hallucinogenic fungus in that area, *Psilocybe yungensis* Singer & Smith has been suggested as a possible identification of the mushroom (Schultes 1966a).

Although psilocybin-containing mushrooms have been collected in South America, there is no evidence that they are employed as sacred inebriants today. It has been suggested that certain anthropomorphic archaeological gold pectorals with mushroom-like domes found in Colombia and dated from 1000 to 1500 A.D. may indicate the former use of shamanic ceremonies of intoxicating mushrooms. Psilocybin-containing mushrooms have been found in Colombia (Schultes and Bright 1979).

The principal genera of hallucinogenic mushrooms of Mexico are small but widespread: *Conocybe* is cosmopolitan; *Panaeolus* is cosmopolitan, occurring primarily in Europe, North America, Central America, and temperate Asia; *Psilocybe,* almost cosmopolitan, is distributed in North America, South America, and

Asia; and *Stropharia,* likewise almost cosmopolitan, ranges through North America, the West Indies and Europe.

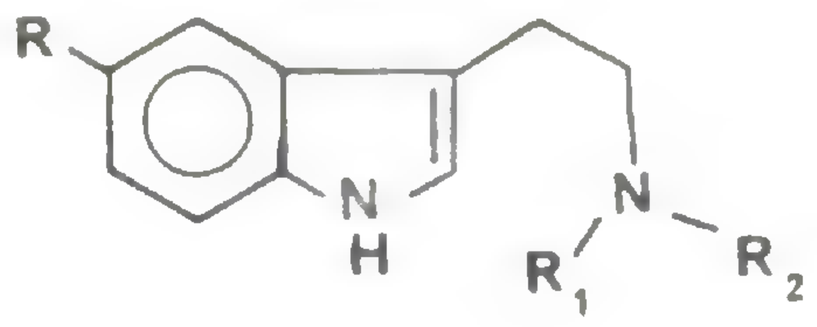
Leguminosae

Anadenanthera Speg.

The New World snuff prepared from beans of *Anadenanthera (Piptadenia) peregrina* (L.) Speg., is known in the Orinoco basin of Colombia and Venezuela, centre of its present use, as *yopo.* It represents probably the cohoba encountered in Hispaniola by Columbus' second voyage in 1496 (Safford 1916a). Von Humboldt, Spruce and other explorers who mentioned it were all astonished by its hallucinogenic potency.

The beans of this medium-sized tree, usually roasted, are crushed and mixed with ashes or calcined shells. The powder is ceremonially blown into the nostrils through bamboo tubes or snuffed individually through bird bone tubes (Carias-Brewer et al. 1976). The intoxication is marked by fury, followed by an hallucinogenic trance and eventual stupour (Granier-Doyeux 1965).

Five indoles have been isolated from *Anadenanthera peregrina,* chief of which are N,N-dimethyltryptamine (XXV) and bufotenine (5-hydroxy-N,N,-dimethyltryptamine) (XXVI) (Fish et al. 1955; and Schultes 1970c, 1976a). Other indoles found in this species are 5-methoxy-N,N,-dimethyltryptamine (XXVII), N_b-methyltryptamine (XXVIII) and 5-methoxy-N_b-methyltryptamine (XXIX).



	R	R_1	R_2
XXV	H	CH_3	CH_3
XXVI	HO	CH_3	CH_3
XXVII	CH_3	CH_3	CH_3
XXVIII	H	H	CH_3
XXIX	CH_3O	H	CH_3

Indirect evidence has suggested that another species, *Anadenanthera colubrina* (Vell.) Brenan, might formerly have been the source of the narcotic snuffs known in southern Peru and Bolivia as *vilca* or *huilca*, and in Argentina as *cebil* (Altschul 1964). Since this species is closely related to the more northern *A. peregrina*, and its chemical constituents are very similar, *A. colubrina* may well have been aboriginally of value as a hallucinogen. Field work has established its contemporary use as a narcotic in northern Argentina (Califano 1975).

Anadenanthera comprises only the two species discussed above. Native to South America, they are distinguished from the closely allied genus *Piptadenia* both morphologically and chemically (Altschul 1964).

Mimosa L.

The allied genus *Mimosa* likewise yields a psychotomimetic, *vinho de jurema*. An infusion of the roots of *M. hostilis* (Mart.) Benth. forms the centre of the ancient Yurema cult of the Kariri, Pankarurú, and other Indians of Pernambuco State, Brazil (Schultes 1965, 1966a). The drink, said to induce glorious visions of the spirit world, was reported to contain an alkaloid originally called nigerine; now known to be N,N-dimethyltryptamine (XXV), the active principle (Gonçalves de Lima 1946).

The genus *Mimosa* comprises about 500 tropical or subtropical herbs and small shrubs, mostly American, but a few are native to Africa and Asia. It is closely related to *Anadenanthera* and *Piptadenia*.

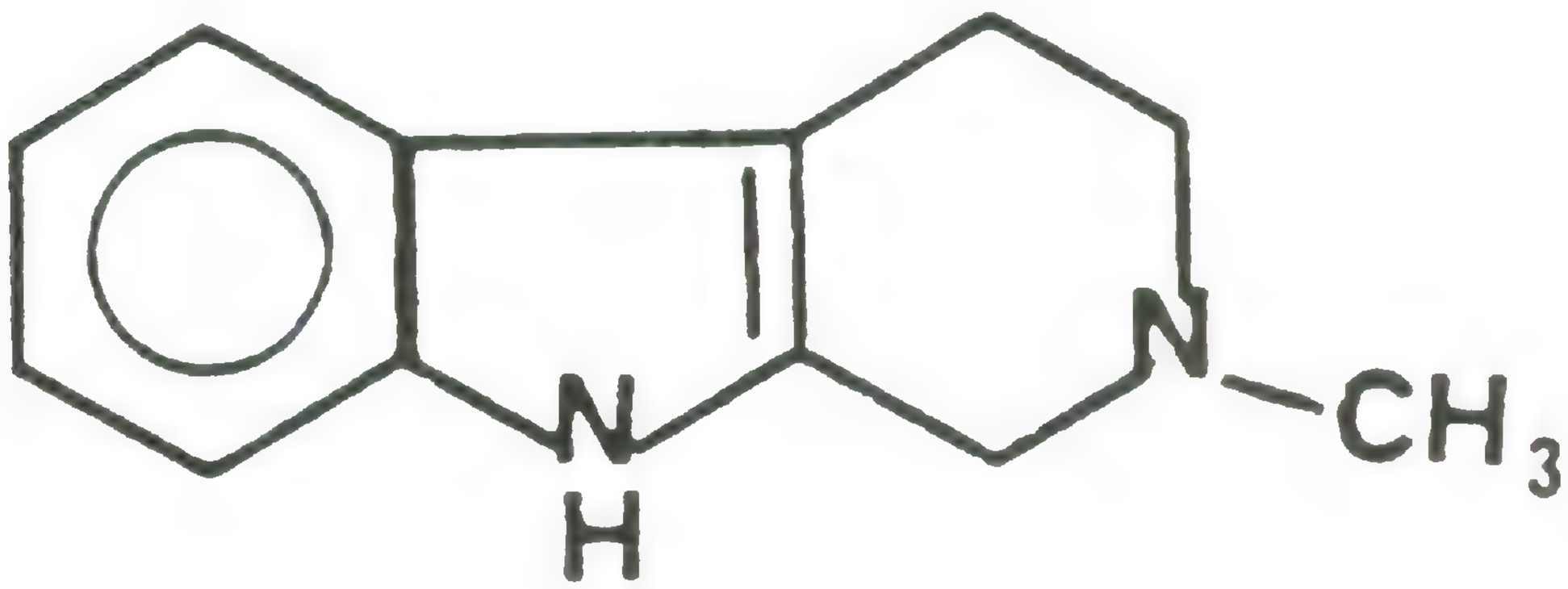
Malpighiaceae

Diplopterys A. Juss.

One of the numerous admixtures of the *ayahuasca-caapi-yajé* drink prepared from bark of *Banisteriopsis Caapi* or *B. inebrians* (which contain β-carboline bases) is the leaf of *Diplopterys Cabrerana**, known in the western Amazon of Colombia and

*The correct name of this plant has recently been shown to be *Diplopterys Cabrerana* (Cuatr.) Gates (Gates 1979). All the chemical studies, however, have been published under *Banisteriopsis Rusbyana* (Ndz.) Mort.

Ecuador as *oco-yajé*. The natives add the leaf to heighten and lengthen visions. Recent examinations indicate that *D. Cabrerana* has in its leaves and stems N,N-dimethyltryptamine and traces of two other narcotically utilized compounds, N,N-dimethyltryptamine and traces of other tryptamines (N_b-methyltryptamine; 5-methoxy-N,N-dimethyltryptamine; and N_b-methyltetrahydro-β-carboline (XXX) (Agurell et al. 1968a and b; Der Marderosian et al. 1968; Poisson 1965). Tryptamines have apparently not hitherto been reported from the Malpighiaceae.



XXX

Myristicaceae
Virola Aubl.

Hallucinogenic snuffs are prepared in northwestern Brazil and adjacent Colombia and Venezuela from the reddish bark "resin" of trees of *Virola,* a genus of 60 to 70 species of Central and South America. The species employed have only recently been identified (Schultes 1979a, 1979b) as *V. calophylla* Warb. and *V. calophylloidea* Markgr. in Colombia and *V. theiodora* (Spr. ex Benth.) Warb. and *V. elongata* (Spr. ex Benth.) Warb. in Brazil (Carias-Brewer and Steyermark 1976; Maia and Rodrigues 1974b,c; Schultes 1954; Schultes et al. 1969; Schultes and Holmstedt 1968; Seitz 1967). The most intense use of this snuff, called *yakee; paricá, epena,* and *nyakwana,* centers among the Waikas of Brazil and Venezuela. In Colombia, only witch

doctors employ it; but in Brazil the intoxicant is taken by all adult males in excess, either individually at any time or ritually at endocannibalistic ceremonies amongst the Waikas. The resin, which is boiled, dried, pulverized, and occasionally mixed with powdered leaves of a *Justicia* species and bark-ashes of *Theobroma subincanum* Mart. or *Elizabetha princeps* Schomb. ex Benth., acts rapidly and violently. Effects include excitement, numbness of the limbs, twitching of facial muscles, nausea, hallucinations, and finally a deep sleep; use is frequent and it enters into Waika beliefs about the spirits resident in the drug.

Contemporary investigations indicate that the snuff prepared from *Virola theiodora* contains normally up to 8% 5-methoxy-N,N-dimethyltryptamine, with lesser amounts of N,N-dimethyltryptamine (Agurell et al. 1968b; Holmstedt 1965). There is appreciable variation in alkaloid concentration in different parts (leaves, bark, root) of *V. theiodora,* but the content in the bark resin may reach as high as 11%. Two new β-carbolines have likewise been found in *V. theiodora* (Agurell et al. 1968b).

Of other species of *Virola* investigated, *V. rufula* (Mart. ex A.DC.) Warb. contains substantial amounts of tryptamines and *V. calophylla,* one of the species employed in the preparation of snuff in Colombia, contains high amounts of alkaloids, apparently in the leaves alone. *V. multinervia* Ducke and *V. venosa* (Benth.) Warb. are almost devoid of alkaloids (Agurell et al. 1968b). Recently, a number of hallucinogenic substituted tryptamines have been isolated from *V. peruviana* (A.DC.) Warburg, a suspected South American hallucinogenic plant (Lai et al. 1973).

The Witotos, Boras, and Muinanes of Amazonian Colombia utilize the resin of a *Virola,* now identified as *V. theiodora,* orally as an hallucinogen (Schultes 1969e; Schultes and Swain 1976). Small pellets of the boiled resin are rolled in a "salt" left following evaporation of the filtrate of bark ashes of *Gustavia Poeppigiana* Berg ex Mart. and other plants and ingested to bring on a rapid intoxication, during which the witch doctors see and speak with "the little people". There are suggestions that Venezuelan Indians may smoke *V. sebifera* Aubl. as an intoxicant (Schultes 1969e).

Rubiaceae

Psychotria L.

Among the sundry admixtures employed to "strengthen" and "lengthen" the effects of the hallucinogenic drink prepared from *Banisteriopsis Caapi* (Spr. ex Griseb.) Morton and *B. inebrians* Morton in the western Amazon, one of the most commonly added is the leaves of *Psychotria* (Schultes 1967). One species used in Ecuador and Peru, *P. viridis* (Schultes 1966a, 1970c), has recently been shown to contain N,N,-dimethyltryptamine (Rivier and Lindgren 1972). The same species, and another not yet definitely identified, are similarly used in the Acre Territory, Brazil (Prance 1972). Tryptamines have apparently not hitherto been reported from the Rubiaceae.

The genus *Psychotria* comprises more than 700 species from the warmer parts of both hemispheres, many of which have important roles in folk medicine or are poisons.

HALLUCINOGENS OF UNCERTAIN USE OR CHEMICAL COMPOSITION

Sundry plants known to possess psychoactive constituents may be employed as hallucinogens, but corroboratory evidence is necessary. Others are known to be used for their psychotomimetic properties, but the chemical principles responsible for the effects are of uncertain or undetermined structure.

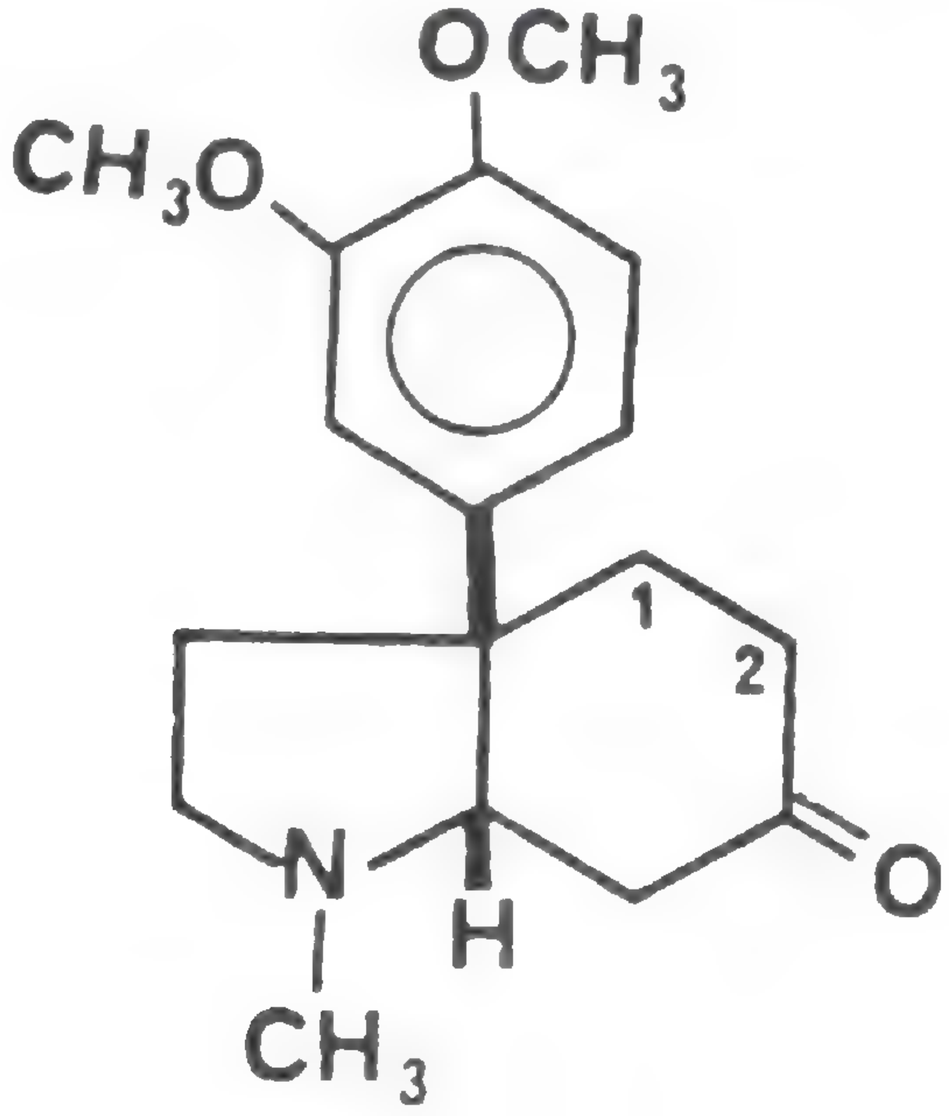
Aizoaceae

Mesembryanthemum L.

More than 225 years ago, the Hottentots of South Africa were reported using a narcotic called *kanna* or *channa*. At the present time, this name applies to sundry species of *Mesembryanthemum (Sceletium),* but especially to *M. tortuosum* L. There is no recent evidence, however, that these are hallucinogenically employed. Other plants—*Sclerocarya Caffra* Sond. of the Anacardiaceae and *Cannabis*—have been suggested as possible identifications (Lewin 1927; Schultes 1967; Schultes and Hofmann 1979).

Several species of *Mesembryanthemum* known to cause a state of stupour when ingested have yielded alkaloids: mesembrine (XXXI) and mesembrenine (XXXII). Both have the

crinane-type characteristic of many amaryllidaceous alkaloids, but differ in having an open ring (Popelak and Lettenbauer 1967). There are about 1000 species of *Mesembryanthemum, sensu lato,* in the xerophytic regions of South Africa. About two dozen species have been split off into a group often recognized as a distinct genus, *Sceletium.*



XXXI

XXXII $\Delta^{1.2}$

Amaryllidaceae

Pancratium L.

The Bushmen of Dobe, Botswana, consider *Pancratium trianthum* Herbert, a bulbous perennial known locally as *kwashi,* to be psychoactive (Schultes 1970a). Rubbing the bulb over incisions on the head is said to induce visual hallucinations. Nothing is known of any possible psychotomimetic constituents, although toxic alkaloids of the tazettine type are characteristic of the genus (Amico et al. 1972). Some of the 15 species of *Pancratium,* mainly Asiatic and African, possess toxic principles, chiefly alkaloids. Some species are employed in folk medicine; others are potent cardiac poisons.

Apocynaceae

Prestonia R. Br.

The source of the hallucinogenic *yajé* of the western Amazon has been reported as *Prestonia (Haemadictyon) amazonica* (Benth.) Macbride an identification allegedly based on misinterpretation of field data and guesswork (Reinburg 1921). Although this assumption is well established in the botanical and chemical literature, recent evaluation of the evidence seriously discredits this suggestion (Schultes and Raffauf 1960). A report of N,N-dimethyltryptamine in *P. amazonica* (Hochstein and Paradies 1957) was based on an erroneous identification, without voucher specimens, of an aqueous extract of the leaves of a vine which may well have been *Diplopterys Cabrerana (Banisteriopsis Rusbyana).*

Cactaceae

Ariocarpus Scheidw.

The Tarahumara Indians of northern Mexico employ *Ariocarpus fissuratus* (Engelm.) K. Schum., called *sunamí hikuri* or *cimarrón,* as a narcotic, asserting that it is stronger than true peyote (*Lophophora*) (Schultes 1967, 1970a).

There are five species known in this genus, all Mexican (Agurell 1969; Der Marderosian 1967a).

Epithelantha Weber ex Britt. & Rose

The Tarahumara likewise use *Epithelantha micromeris* (Engelm.) Weber ex Britt. & Rose as a narcotic (Bye 1979; Schultes 1970c). Chemical studies apparently have not been carried out on representatives of this genus of three species of southwestern United States and Mexico.

Pachycereus (A. Berger) Britt. & Rose

Another cactus utilized as a narcotic by the Tarahumara is the gigantic *Pachycereus pecten-aboriginum* (Engelm.) Britt. & Rose, which they call *cawé* (Bye 1979). Carnegine has been reported from this species (Agurell 1969). Another species, *P. marginatus* (DC.) Britt. & Rose, is said to contain pilocereine (Agurell 1969).

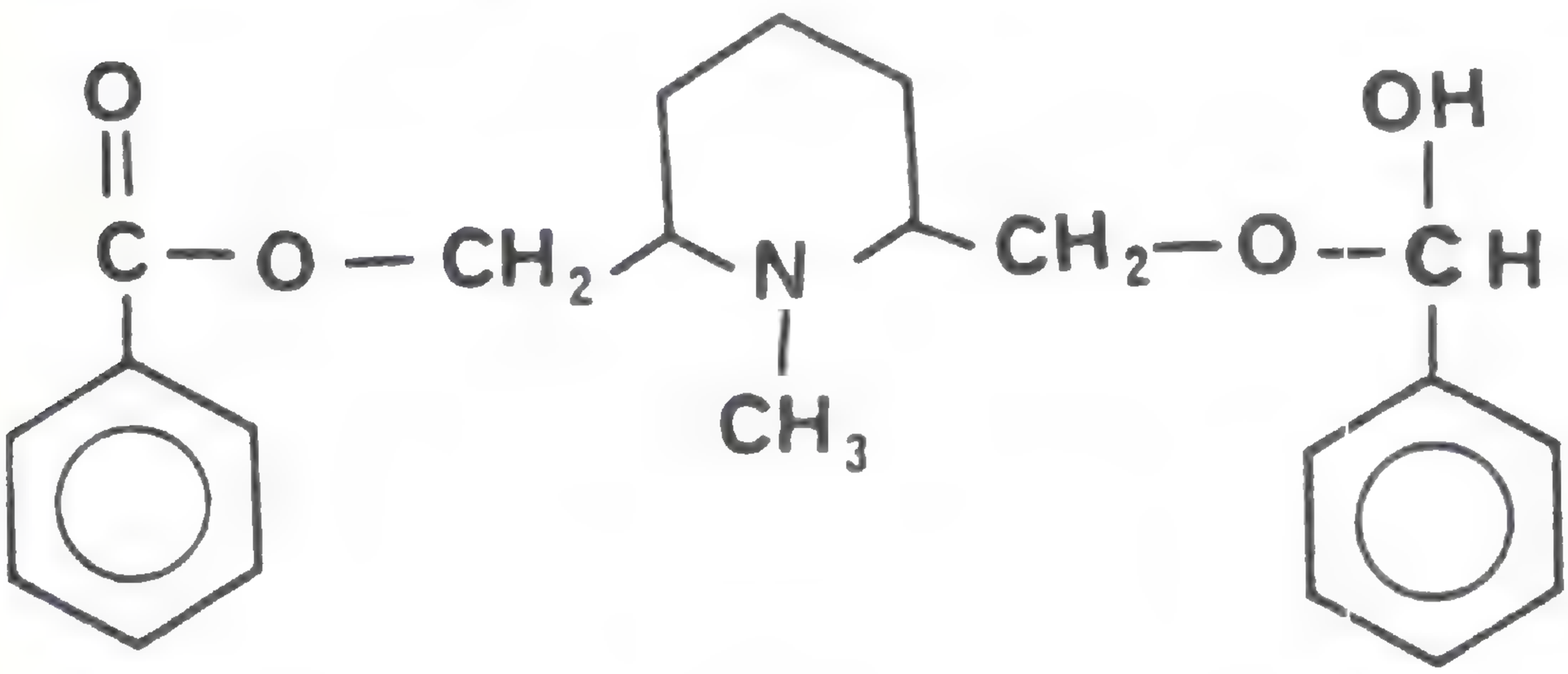
There are five species of *Pachycereus,* all native to Mexico.

Campanulaceae

Lobelia L.

Lobelia Tupa L., a tall polymorphic herb of the Andean highlands known as *tupa* or *tabaco del diablo,* is a widely recognized poison. Chilean peasants are said to employ the juice to relieve toothache, and, while the Mapuches of Chile reputedly smoke the leaves for their narcotic effect, there is as yet no certainty that this plant is truly hallucinogenic (Naranjo 1969).

The leaves of *Lobelia Tupa* contain the piperidine alkaloid lobeline (XXXIII), a respiratory stimulant, and the diketo- and dihydroxy-derivatives, lobelamidine and norlobelamidine (Kaczmarek and Steinegger 1958, 1959).



XXXIII

There are 350 to 400 cosmopolitan species of *Lobelia,* mostly tropical and subtropical, especially in the Americas. It is usually classified with several other large genera as a subfamily, Lobeliodieae, of the Campanulaceae, but the subfamily may sometimes be treated as a distinct family, Lobeliaceae.

Compositae

Calea L.

A common Mexican shrub, *Calea Zacatechichi* Schlechten., belonging to a tropical American genus of about 100 species, represents one of the most recently reported hallucinogens. The Chontal Indians of Oaxaca take the leaves as an infusion for

divination, calling them *thle-pela-kano* or "leaf of god" and believing them to clarify the senses (MacDougall 1960b). Although the plant has long been used in folk medicine (Díaz 1979), chemical studies have revealed only a large number of polyacetylenes, sesquiterpene lactones, chromenes, triterpenes and flavonoids (Bohlmann and Zdero 1977; Quijano, et al. 1977, 1978, 1979), none of which could be expected to account for hallucinogenic effects. Preliminary investigations have indicated the presence of a possible new alkaloid (Holmstedt, pers. commun.).

Coriariaceae

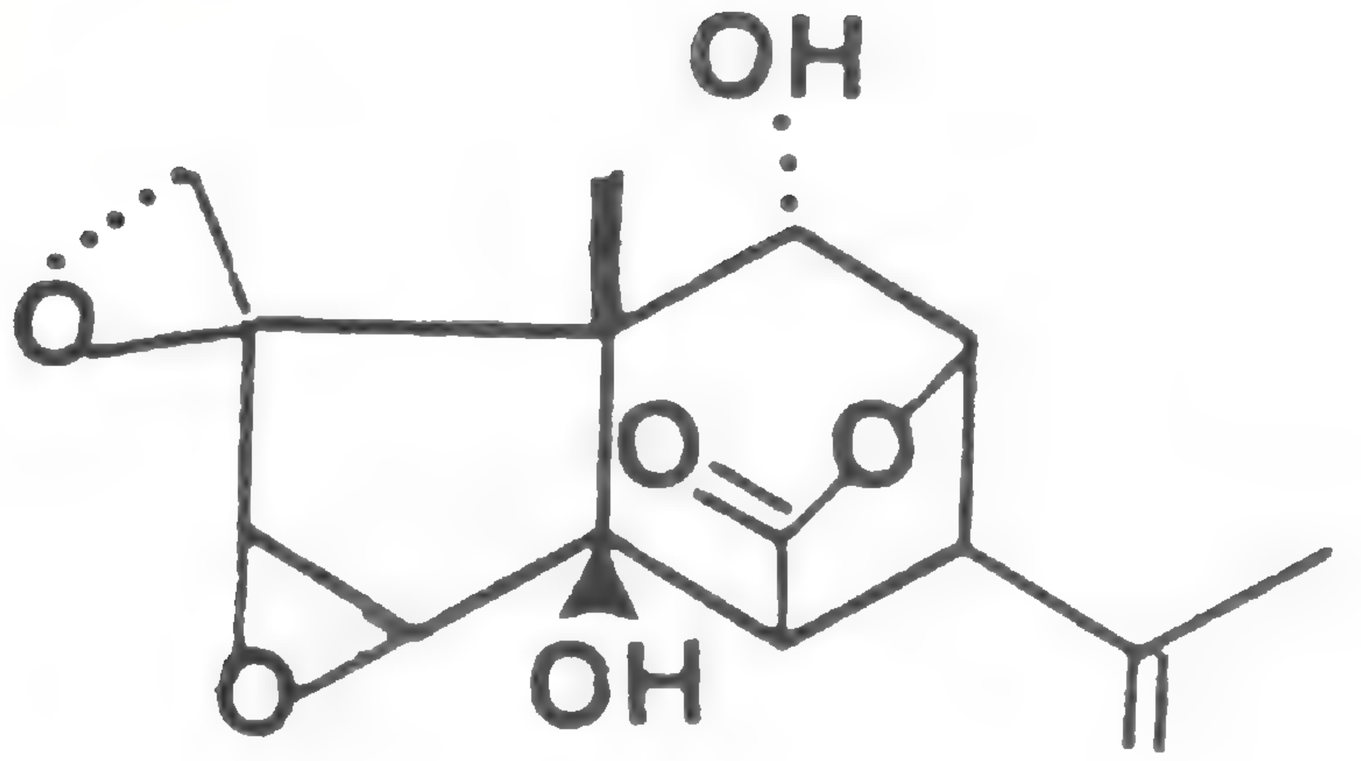
Coriaria L.

Long recognized in the Andes as dangerously toxic to animals, *Coriaria thymifolia* H. & B. ex Willd. has recently been reported as hallucinogenic, giving a sensation of flight. The fruits, reputedly containing catechol derivatives, are eaten for inebriation in Ecuador, where the plant is called *shanshi* (Naranjo, 1969; Naranjo and Naranjo, 1961).

Several toxic and structurally related sesquiterpenes have been isolated from the Coriariaceae: coriaric acid, coriamyrtin, coriatin, tutin (XXXIV), and pseudotutin (Kariyone and Ohsumi 1943; Kinoshita 1929, and 1930; Lowe and White 1972; Maranon, 1932).

Species of *Coriaria* have long been known as toxic plants, and this toxicity could be related to the alleged hallucinogenic activity of *C. thymifolia* (Chelvers 1972).

The genus, the only one in the family, has some 15 species distributed in Eurasia, New Zealand, and highland tropical America.



XXXIV

Desfontainiaceae

Desfontainia R. & P.

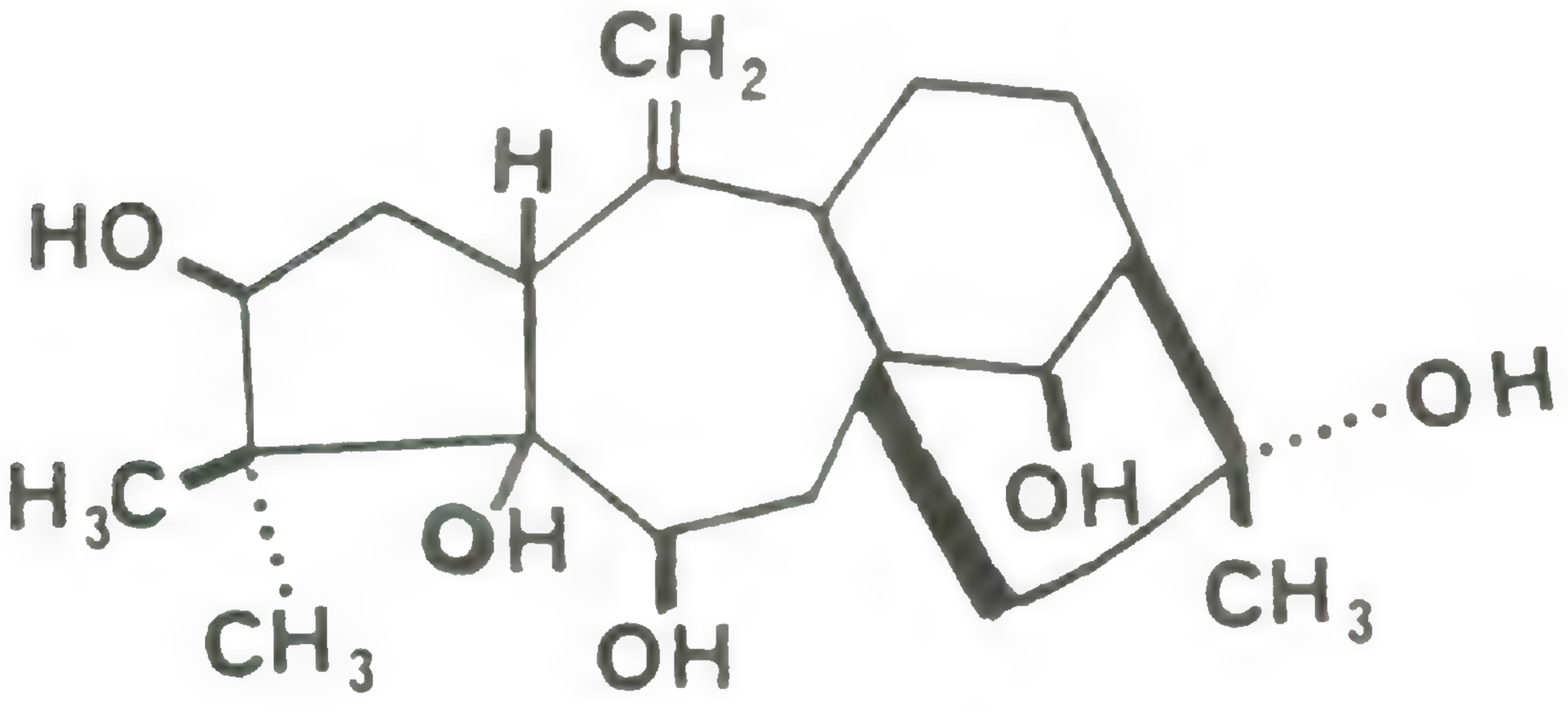
It is reported that the leaves of *Desfontainia spinosa* R. & P. are employed in southern Chile as a narcotic and medicinally (Schultes 1970c). The narcotic use of this plant has now been substantiated in Colombia (Schultes 1977a). Chemical investigation of this anomalous plant have apparently not been carried out. The genus, with some five Andean species, comprises a family which appears to be related to the Loganiacae and which is sometimes placed in the Potaliaceae.

Ericaceae

Pernettya Gaudich.

Pernettya furiens (Hook. ex DC.) Klotsch., known in Chile as *huedhued* or *hierba loca,* is toxic. When consumed in quantity, the fruits induce mental confusion and madness or permanent insanity and exercise a narcotic effect similar to that of *Datura* (Schultes 1970c). This species has apparently not been chemically investigated. Its activity may be due to grayanotoxin III (andromedotoxin) (XXXV), a poisonous principle widely distributed in the family. *Pernettya parvifolia* Benth., called *taglii* in Ecuador, is noted as a toxic plant containing grayanotoxin III and the fruit of which, when ingested, causes hallucinations and other psychic and motor alterations (Chen and Chen 1939; Naranjo 1969).

Some 25 species of *Pernettya* are known from Tasmania, New Zealand, the highlands from Mexico to Chile, the Galapagos and the Falkland Islands.



XXXV

Gomortegaceae

Gomortega R. & P.

Gomortega Keule (Mol.) I. M. Johnst., an endemic of Chile, where it has the Mapuche Indian names *keule* or *hualhual*, may once have been employed as a narcotic (Schultes 1970c). Its fruits are intoxicating, especially when fresh, due possibly to an essential oil. There is only this single species in the whole family Gomortegaceae.

Himantandraceae

Galbulimima F. M. Bailey

In Papua, the leaves and bark of *agara, Galbulimima Belgraveana* (F. Muell.) Sprague, are taken with the leaves of a species of *Homalomena* to induce a violent intoxication that progresses into a sleep in which visions and dreams are experienced (Barrau 1958). Several uncharacterized isoquinoline alkaloids have been isolated from this plant, but the specific pharmacology of the constituents is not clear. (Willaman and Schubert 1961).

Two or three species of *Galbulimima* occur in eastern Malaysia and northeastern Australia.

Labiatae

Coleus Lour., *Salvia* L.

In southern Mexico, crushed leaves of *Salvia divinorum* Epling & Ját.-M., known in Oaxaca as *hierba de la Virgen* or *hierba de la Pastora,* are valued by the Mazatec in divinatory rites, when other more potent hallucinogens are unavailable (Wasson 1962). Although investigators have experimentally substantiated the psychotomimetic effects, an active principle remains to be isolated from the plant (Schultes and Hofmann 1973 and 1980; Wasson 1962). It has been suggested that *S. divinorum* represents the hallucinogenic *pipiltzintzintli* of the ancient Aztecs (Wasson 1962).

There are some 700 species of *Salvia* in the temperate and tropical parts of both hemispheres, but no other species seems to have been reported as an hallucinogen.

The leaves of two other mints, *Coleus pumilus* Blanco and *C. Blumei* Benth., both native to southeast Asia, are similarly employed by the Mazatec (Wasson 1962). Chemical studies of these two species, at least on the basis of material growing in southern Mexico, have not been reported, and a psychoactive principle is not known in this genus of some 150 species of the Old World tropics. An uncharacterized alkane, sterol and triterpene (García et al. 1973), and the flavonoids aromadendrin and cyanidin 3,5-di-0-β-D-glucosyl *p*-coumarate (Lamprecht et al. 1975) have been isolated from *C. Blumei,* but they would not be expected to induce marked pharmacological effects. However, diterpene quinones of the coleon Q type have been isolated from other species of *Coleus* and one might expect compounds of this type to give rise to some type of biological effect (Arihara et al. 1975).

Leguminosae

Erythrina L.

The reddish beans of *Erythrina* may have been valued as hallucinogens in Mexico. Resembling seeds of *Sophora secundiflora,* they are frequently sold in modern Mexican herb markets under the name *colorines* (Schultes 1970c). Several species contain indole or isoquinoline derivatives and could be hallucinogenic.

The genus occurs in the tropics and subtropics of both hemispheres and comprises some 100 species.

Rhynchosia Lour.

The ancient Mexicans may have valued several species of *Rhynchosia* as narcotics. Modern Oaxacan Indians refer to the toxic seeds of *R. pyramidalis* (Lam.) Urb. and *R. longeracemosa* Mart. & Gal. by the same name, *piule,* which they also apply to the seeds of hallucinogenic morning glories. The black and red *Rhynchosia* beans, pictured together with mushrooms, have been identified on Aztec paintings, thus suggesting hallucinogenic use (Schultes 1937b, 1965, 1969a). An as yet uncharacterized alkaloid has been isolated from *R. pyramidalis* (Ristic and Thomas 1962).

This genus comprises some 300 species of tropical and subtropical plants, especially of Africa and America.

Lycoperdaceae

Lycoperdon Pers.

Puffballs, *Lycoperdon marginatum* Vitt. and *L. mixtecorum* Heim, have been reported as hallucinogens utilized by the Mixtecs of Oaxaca in Mexico at 6000 feet altitude or higher (Heim et al. 1967). There are more than 100 species of *Lycoperdon,* native mostly to the temperate zone in moss-covered forests.

The Mixtec call *Lycoperdon mixtecorum, gí-i-wa* ("fungus of first quality") and *L. marginatum,* which has a strong odor of excrement, *gí-i-sa-wa* ("fungus of second quality"). These two hallucinogens do not appear to occupy the place as divinatory agents that the mushrooms hold among the neighboring Mazatec. The most active species, *L. mixtecorum,* causes a state of half-sleep one-half hour after ingestion of one or two specimens. Voices and echoes are heard, and voices are said to respond to questions posed to them. The effects of the puffballs differ markedly from those of the hallucinogenic mushrooms: they may not induce visions, although definite auditory hallucinations do accompany the intoxication. There is as yet no phytochemical basis on which to explain the intoxication from these two gastromycetes, but there seems to be every indication that

further studies are warranted (Schultes and Hofmann 1979; Díaz 1979).

A species of *Lycoperdon* is likewise employed by the Tarahumara of Mexico in witchcraft (Bye 1979).

Malpighiaceae

Tetrapteris Cav.

The Makú Indians in the northwesternmost sector of the Brazilian Amazon prepare a narcotic drink from the bark of *Tetrapteris methystica* R. E. Schult. A cold-water infusion with no admixtures has a yellowish hue and induces an intoxication with visual hallucinations very similar to that caused by drinks prepared from species of the related genus *Banisteriopsis* (Schultes 1954a). Another species, *T. mucronata* Cav., has been indicated as a source in Amazonian Colombia of an hallucinogenic preparation (Schultes 1975).

No chemical studies have been made of these species of *Tetrapteris,* but, since the genus is close to *Banisteriopsis,* it is not improbable that β-carbolines are the active constituents.

Tetrapteris comprises some 80 species, distributed from Mexico to tropical South America and in the West Indies.

Moraceae

Helicostylis Tréc.

Takini is the Caribbean Indian name given to species of large trees of the moraceous genus *Helicostylis* found in the Guianas and in the northeastern part of the Brazilian Amazonia. The bark contains a reddish sap which has mildly poisonous and intoxicating properties, and the hallucinations produced by it form part of witch doctor ceremonies of the Indians and bush negroes of Surinam (Stahel 1944; Ostendorf 1962; Kloos 1971). Much difficulty has been encountered in attempts to obtain botanically authenticated material for chemical and biological studies. The tree has been identified as a species of *Piratinera* or *Brosimum* of the Moraceae (Hegnauer 1969) or even of the euphorbiaceous genus *Pausandra* (de Goeje 1943). On one occasion, material was collected from the wrong tree deliberatly by natives, as they did not want to disclose the identity of their sacred *takini* (Buckley et al. 1973). More recently, the trees

utilized in preparing *takini* have been identified as *H. tomentosa* (P. & E.) Rusby and *H. pedunculata* Ben. (Buckley et al. 1973).

One chemical report on some constituents of takini bark has appeared, but the authors indicate uncertainty concerning the botanical classification of their plant material (Bick and Clezy 1958).

Extracts prepared from the inner bark of both of the aforementioned species have now been pharmacologically evaluated and both are reported to elicit central nervous system depressant effects in mice and rats, and certain of the effects are described as similar to those expected with *Cannabis sativa* (Buckley et al. 1973). Because of the close taxonomic relationship of *Helicostylis* to *Cannabis* (which is classified by some botanists in the Moraceae), one might expect similar types of chemical constituents in both genera. Whether or not the effects are due to the presence of cannabinoids remains to be determined.

Maquira Aubl.

An Amazon jungle tree, *Maquira (Olmedioperebea) sclerophylla* (Ducke) C. C. Berg, represents one of the most poorly understood hallucinogens. The fruits reputedly are the source of an intoxicating snuff employed formerly by Indians of the Pariana region of central Amazonia (Schultes 1970c). A study has been reported in which water and ethanol extracts of *Olmedeoperebea (Maquira) calophyllum* (P. & E.) C. C. Berg wood were devoid of *Cannabis*-like activity in several types of animal tests, even at doses 10 times those required for *C. sativa* to demonstrate such effects (Carlini and Gagliardi 1970). These authors indicate that they are continuing their studies with extracts of *M. calophyllum* and *M. sclerophylla* leaves and flowers, but their results have not as yet been published.

Solanaceae

Brunfelsia L.

Only recently has reliable evidence of the narcotic use of *Brunfelsia* come to light, and further field work is needed to establish the extent of this use. Several vernacular names suggest that the intoxicating properties have long been valued (Schultes 1967). *B. grandiflora* D. Don and *B. Chiricaspi* Plowm. are

frequently added to the narcotic drink prepared from *Banisteriopsis* (Plowman 1973). A species described as *B. Tastevinii* Ben. is reputedly utilized by the Kachinaua of the Brazilian Amazon to prepare an hallucinogenic drink, but this report needs confirmation (Schultes 1970c). Preliminary studies have failed to disclose any chemical constituent in the genus which might be hallucinogenic.

Brunfelsia is a tropical American genus of some 25 species, and is somewhat intermediate between the Solanaceae and Scrophulariaceae.

Iochroma Benth.

The occasional use of tea of the leaves and bark of *Iochroma fuchsioides* (HBK.) Miers as an hallucinogen has been established amongst the Kamsá Indians of Sibundoy in southern Colombia. In the "old days", according to shamans, it was used much more frequently, but to-day, because it is highly toxic, its use is restricted.

This shrub is known as *flor de quinde* ("hummingbird flower"), *nacadero, paguanda* and, in Kamsá, *totubjansuch*. It is also occasionally referred to as *borrachero*, a common name for many intoxicants (Schultes 1977b).

Chemical studies have not yet been carried out on any species of *Iochroma*.

Petunia L.

Petunia (*shanín* in Ecuador) has been reported as an hallucinogen in South America; it is said to induce feelings of levitation (Haro A. 1971).

Interest in Petunia as a possible hallucinogen appears now to be unwarranted, based on an erroneous literature report which it has not been possible to substantiate. Preliminary investigations show no alkaloids with Dragendorff's reagent (Butler, Robinson and Schultes 1981).

Sapindaceae

Ungnadia Endl.

Archeological findings suggest that *Ungnadia speciosa* Endl. seeds may once have been employed as an hallucinogen in Mexico and the Trans-Pecos, Texas (Adovasio and Fry 1976).

The seeds of this tree—*Texas buckeye*—are considered toxic, but as yet no hallucinogenic principles have been reported from the species.

Zingiberaceae

Kaempferia L.

Vague reports indicate that in New Guinea *Kaempferia Galanga* L., known as *maraba,* is employed as an hallucinogen (Schultes 1970c), but phytochemical corroboration is lacking. The rhizome of *K. Galanga,* containing essential oils, is highly prized as a condiment and medicine in tropical Asia.

There are some 70 species of *Kaempferia* distributed in tropical Africa, India to southern China, and western Malaysia.

SUMMARY

This review has attempted to survey those higher plants and fungi recorded in the literature as having been used by primitive or modern peoples as hallucinogens. The ethnomedical history for each, where known, has been summarized, and the active principles, when known, have been identified. The active principles can be broadly classified into a small group of non-nitrogenous compounds and a larger group of nitrogenous substances. In the latter group, the active principles can be classified into eight major skeletons or ring systems, with the indole nucleus being predominant.

A number of minor plants alleged to have been used for hallucinatory purposes at one time or another have been listed in Table 1 for completeness, and a comprehensive bibliography has been provided for the reader having more than a peripheral interest in the subject matter. The bibliography is not exhaustive, however, due to space restrictions.

More than 200 species of higher plants are represented in the survey. That they are widely distributed in the Plant Kingdom is demonstrated by the fact that they belong in 146 genera of more than 50 families. It is truly amazing that of these more than 200 species of hallucinogenic plants, the active principles are known for only about 45. Perhaps the major deterrents for more accelerated studies in this field are two: 1) the lack of a good

Table 1.—Additional Plants Alleged to Have Hallucinogenic Properties[a]

Family	Genus and Species
Aizoaceae	*Mesembryanthemum expansum* L.
	Mesembryanthemum tortuosum L.
Amaranthaceae	*Alternanthera* sp.
	Iresine sp.
Amaryllidaceae	*Ungernia minor*
Apocynaceae	*Haemadictyon* sp.
	Malouetia Tamaquarina A. DC.
	Vinca minor L.
	Voacanga Dregei E. Mey
Araceae	*Arisaema Draconium* Schott
	Panax Schinseng Nees
Anacardiaceae	*Sclerocarya Caffra* Sond.
	Sclerocarya Schweinfurthiana Schinz.
Bignoniaceae	*Tanaecium nocturnum* (Barb.-Rodr.) Bur. & K. Schum.
Boletaceae	*Boletus manicus* Heim
	Heimiella anguiformis Heim
Boraginaceae	*Borago officinalis* L.
Burseraceae	*Boswellia serrata* Roxb.
Cactaceae	*Astrophytum* sp.
	Aztekium sp.
	Carnegiea gigantea (Engelm.) Britt. & Rose
	Cereus peruvianus (L.) Mill.
	Coryphantha compacta (Engelm.) Britt. & Rose
	Dolichothele sp.
	Echinocereus triglochidiatus Engelm.
	Epiphyllum sp.
	Mammillaria Craigii G. Lindsay
	Mammillaria Grahamii Engelm.
	Mammillaria senilis Lodd. ex Scheer
	Neoraimonida macrostibas (Schum.) Britton & Rose
	Obregonia sp.
	Solisia sp.
Campanulaceae	*Lobelia inflata* L.
Cannabaceae	*Humulus Lupulus* L.
Compositae	*Artemisia Absinthium* L.
	Cacalia cordifolia L. fil.
	Cineraria aspera Thunb.
	Helichrysum foetidum (L.) Moench
	Lactuca virosa L.

[a]For original references see Farnsworth, 1972, 1974.

Table 1. *(continued)*

Family	Genus and Species
	Matricaria Chamomilla L.
	Senecio sp.
	Tagetes lucida Cav.
Convolvulaceae	*Ipomoea argyrophylla* Vatke
	Ipomoea Batatas L.
	Ipomoea hederacea Jacq.
	Ipomoea muricata Jacq.
	Stictocardia tiliaefolia (Choisy) Hall. f.
Coprinaceae	*Copelandia cyanescens* (Berk. & Br.) Singer
Cucurbitaceae	*Echinocystis lobata* Torr. & Gray
Cycadaceae	*Dioon edule* Lindl.
Cyperaceae	*Scirpus* sp.
Equisetaceae	*Equisetum arvense* L.
Ericaceae	*Gaultheria* sp.
Euphorbiaceae	*Monadenium Lugardae* N.E. Br.
	Sebastiania Pavoniana Muell.-Arg.
Gnetaceae	*Ephedra nevadensis* Wats.
Gramineae	*Cymbopogon densiflorus* Stapf
	Lagochilus inebrians Bunge
Labiatae	*Leonotis Leonurus Ait. f.*
	Nepeta Cataria L.
	Ocimum micranthum Willd.
Lauraceae	*Cinnamomum Camphora* (L.) T. Nees & Eberm.
Leguminosae	*Astragallus Besseyi* Rdb.
	Astragallus amphioxys A. Gray
	Astragallus molissimus Torr.
	Caesalpinia sepiaria Roxb.
	Canavalia maritimia Petit-Thouars
	Erythrina americana Mill.
	Mimosa verrucosa Benth.
	Mucuna pruriens (L.) DC.
	Rhynchosia phaseoloides DC.
	Swainsonia galegifolia R.Br.
	Zornia latifolia DC.
Loganiaceae	*Gelsemium sempervirens* Ait.
Loranthaceae	*Phrygilanthus eugenioides* (L.) HBK.
Lythraceae	*Heimia myrtifolia* Hort. Berol. ex. Cham. & Schlecht.
Malpighiaceae	*Banisteriopsis quitensis* (Ndz.) Morton
	Mascagnia psilophylla (Juss.) Griseb. var. *antifebrilis* (R. & P.) Ndz.
Menispermaceae	*Cocculus Leaeba* DC.
Musaceae	*Musa sapientum* L.
Myristicaceae	*Virola cuspidata* (Benth.) Warb.

Table 1. *(continued)*

Family	Genus and Species
Nyctaginaceae	*Mirabilis multiflora* A. Gray
Nymphaeaceae	*Nymphaea ampla* (Salisb.) DC.
	Nymphaea caerulea Sav.
Orchidaceae	*Oncidium Cebolleta* (Jacq.) Sw.
Palmae	*Areca Catechu* L.
Pandanaceae	*Pandanus* sp.
Papaveraceae	*Argemone mexicana* L.
	Eschscholzia californica Cham.
	Papaver somniferum L.
Passifloraceae	*Passiflora incarnata* L.
Phytolaccaceae	*Phytolacca acinosa* Roxb.
Piperaceae	*Piper Betle* L.
	Piper methysticum Forst.
	Piper nigrum L.
Ranunculaceae	*Ranunculus acris* L.
Rubiaceae	*Corynanthe Johimbe* K. Schum.
	Mitragyna speciosa Korth
Russulaceae	*Russula* spp.
Rutaceae	*Evodia Bonwickii* F. v. Muell
Sapindaceae	*Paullinia Yoco* R.E. Schult. & Killip
	Nephelium Topengii (Merr.) H.S Lo
Saxifragacea	*Hydrangea paniculata* Sieb.
Scrophulariaceae	*Digitalis purpurea* L.
Solanaceae	*Capsicum frutescens* L. var. *grossum* (L.) Bailey
	Cestrum laevigatum Schlecht.
	Datura fastuosa L.
	Duboisia Hopwoodii F. v. Muell.
	Hyoscyamus albus L.
	Hyoscyamus muticus L.
	Nicotiana rustica L.
	Nicotiana Tabacum L.
Styracaceae	*Styrax Tessmannii* Perk.
Turneraceae	*Turnera diffusa* Willd. ex Schult.
Umbelliferae	*Daucus Carota* L.
	Ferula Sumbul Hook. f.
	Foeniculum vulgare Mill.
	Peucedanum japonicum Thunb.
	Siler divaricatum Benth. & Hook. f.
Valerianaceae	*Valeriana officinalis* L.
Zingiberaceae	*Zingiber officinale* Rosc.

animal model which the interested chemist would find necessary in monitoring his isolation work; and 2) the sparsity of field work of a scientific nature in the fast disappearing aboriginal societies. Further ethnobotanical field work will surely lead to the discovery of additional hallucinogenic plants and to more information on those already known.

The Plant Kingdom remains a fertile and almost virgin territory for those interested in the discovery of new psychoactive drugs, not to mention other types of biologically active compounds waiting in silent hiding. Can we afford to neglect any longer the hunting ground that until now has provided, mainly through folklore and serendipity, leads that the pharmaceutical industry has turned into products having annual sales in excess of $3,000,000,000 in the American prescription market alone? (Farnsworth and Morris 1976).

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BOTANICAL MUSEUM LEAFLETS
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INDOLE ALKALOIDS IN AMAZONIAN MYRISTICACEAE: FIELD AND LABORATORY RESEARCH

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BOTANICAL CONSIDERATIONS

Indians of the Amazon—especially of the northwest Amazon—and of adjacent parts of the Orinoco have employed various species of the myristicaceous genus Virola for many years as the bases of hallucinogenic preparations. A resin-like liquid of the inner bark of the trees is elaborated into an intoxicating snuff and is prepared in pellets for oral consumption; it is even on occasion ingested raw without any preparation.

Although undoubtedly a custom of great age, discovery of the use of Virola as an important hallucinogen is recent. In the early part of this century, the German anthropologist Theodor Koch-Grünberg reported that the Yekwana Indians of the Orinoco of Venezuela were utilizing an intoxicating snuff prepared from the "bark of a tree." He wrote that, when the bark was "pounded up, it is boiled in a small earthenware pot, until all the water has evaporated and a sediment remains at the bottom of the pot. This sediment is toasted in the pot over a slight fire and is then

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finely powdered with the blade of a knife." It was called *hakudufha* by the Yekwana (Koch-Grünberg 1923).

In 1938, the Brazilian botanist Adolpho Ducke indicated that, in the Rio Negro, the Brazilian Indians made a snuff called *paricá* from the leaves of *Virola theiodora* and *V. cuspidata* (Ducke 1938; 1939).

The source of the narcotic snuff was, however, not definitively identified until 1954, when voucher specimens and field studies indicated that the leaves are not used but that a bark exudate is the real source of the snuff. At that time, the Indians of the Río Apaporis of Amazonian Colombia were found to be using in ritual ceremonies of the medicine men an intoxicating snuff made from the red "resin" of the inner bark or from scrapings of the inner bark itself of *Virola calophylla, V. calophylloidea* and possibly *V. elongata* (Schultes 1954).

Later, it was learned that the Witoto Indians of Colombia did not utilize the red "resin" of the bark in the form of snuff but did value it in pellets orally ingested as a magic and ceremonial hallucinogen (Schultes 1969; Schultes and Swain 1976). More recent field work amongst the Boras and Witotos of Peru has indicated the use of *Virola Pavonis* and *V. elongata* as well as possibly *V. surinamensis* and *V. loretensis.* The Boras likewise point out *Iryanthera macrophylla* of a related myristicaceous genus as the source of a narcotic paste. This represents the first time that a genus other than Virola has been known to be involved in the myristicaceous hallucinogens of tropical South America.

Reports from the field work of an anthropologist—Peter L. Silverwood-Cope—inform us that the primitive, nomadic Makú Indians of the Río Piraparaná in Amazonian Colombia drink the "resin" directly, with no preparation and no admixture, for its hallucinatory effects (Schultes 1978, 1979).

There are suggestions that the bark of *Virola sebifera* may be smoked in Venezuela. Several herbarium collections note that the inner bark is smoked by witch doctors at dances when curing fevers and that they boil the bark "to drive away evil spirits." (Schultes and Hofmann 1980).

It is now known that a number of species of Virola are employed hallucinogenically in Brazil, Colombia, Peru and Venezuela: *V. calophylla, V. calophylloidea, V. cuspidata, V. elongata, V. Pavonis, V. surinamensis* and *V. theiodora* (Schultes and Hofmann 1979; 1980).

The hallucinogenic constituents are believed to be present in the almost colourless exudate from the inner surface of the outer bark which appears as soon as the bark is stripped from the tree. This exudate rapidly darkens to a reddish brown in a typical oxidase type reaction and dries to a hard shiny mass. In specimens of bark dried for chemical examination, it appears as a sticky, dark reddish brown, gummy material which has been shown to contain tryptamines and other indolic hallucinogens (Agurell, Holmstedt, Lindgren and Schultes 1968; 1969).

It has been observed, however, that the only reason for scraping the inner surface of the bark (phloem) is to obtain all traces of cambium which might adhere to it. The drug itself, whether snuff or pellets, is prepared from the cambial sap only, which is first quickly boiled, causing coagulation of protein and perhaps polysaccharides, and then simmered slowly to reduce the volume to near dryness. This gives the sticky brownish material from which the "resin" snuff or pellets are prepared. The whole process is similar to that used for the isolation of other natural products from the cambium of other trees, such as coniferin from gymnosperms, for example; except that today one would employ ethyl alcohol or acetone, rather than heat, to destroy enzyme activity which might otherwise act adversely on the desired product (Schultes and Swain 1976).

Virola *Aublet*

A tropical American genus of 45 to possibly 60 species of tropical forest trees widely distributed in Central and South America, Virola is abundant, especially in the Amazon, where it is esteemed as the source of an hallucinogen, in native medicine and as the basis of an arrow poison (Schultes and Holmstedt 1968, 1971; Prance 1970).

Virola is generally known as *cumala* in the Peruvian Amazon: various species are distinguished as *cumala blanca, cumala roya,*

cumala caspi. In Brazil, the general name for Virola is *ucuúba-ucuúba branca, ucuúba preta, ucuúba vermelha.* The Venezuelan species have many vernacular names: *camaticaro, cedrillo, cozoiba, cuajo, cuajo negro, cudo rebalsero, sangerino, trompillo.* In Colombia, the most widely used common name is *cuajo,* although in the Amazonian regions this term is rarely employed.

Native names for species of Virola are many. The most frequently met with in the literature, mainly because of the use of the plants as hallucinogens, are *yakee* (Puinave), *yato* (Kuripako) in Colombia; *epena* or *nyakwana* (Waika) in Brazil and Venezuela; *paricá* (Tukano) in Brazil and Colombia; *oo-koó-na* (Witoto) in Colombia and Peru; *krüdeeko* (Bora) in Peru. In Amazonian Colombia, the Yukunas know *V. calophylla* as *are-de-yé*; the Barasanas as *yeag aseiiñ*. The Kubeo call *V. calophylloidea ko-gá*; the Barasanas, *rose-nameti.* They refer to the related *V. elongata* by the slight variant: *rose-nemee. V. peruviana* is called *rá-pa* by the Kabuyarí Indians of the Río Apaporis. The Barasanas know *V. carinata* as *nat-sin-neme;* the Makús, as *bon-amí*; the Makunas, as *lasil-me-je-ju.*

The family Myristicaceae was originally treated as monogeneric. The concept Virola, proposed by Aublet in 1775, was included in the genus Myristica. Many of the species now considered to represent Virola were described by Spruce or Spruce and Bentham as belonging to Myristica. In his letters and field notes, Spruce frequently referred to Virolas as "nutmegs," as the well known source of the spice nutmeg is *Myristica fragrans.* When Warburg published his monumental monographic studies on the family Myristicaceae in 1897, he restricted Myristica to Old World representatives and recognized as a valid concept Aublet's Virola, into which he transferred a large number of species which, until then, had been accommodated in Myristica. The same specialist set up to accommodate other tropical American myristicaceous species earlier described as Myristica the new generic concepts of Compsoneura, Dialyanthera, Iryanthera and Osteophloem. Subsequent taxonomists have accepted Warburg's treatment of the generic composition of the family: A. C. Smith, Adolpho Ducke and William Rodrigues. It appears that the most important

species of Virola for the preparation of the halluci-nogenic snuff or paste is *V. theiodora.*

Virola theiodora occurs mainly in the western Amazonia of Brazil and Colombia, possibly also in adjacent parts of Peru and Venezuela. It is especially abundant in the Rio Negro drainage-area. The tree is normally found in well drained forests.

The analyses which follow have been carried out on material without regard as to whether or not it enters into native hallucinogenic preparations.

CHEMICAL CONSIDERATIONS

In 1977, the Alpha-Helix Amazon Expedition 1976-1977, Phase VII, dedicated to *Ethnopharmacological Studies of the Flora and Fauna of the Pebas Region of the Peruvian Amazon,* presented an unparalleled opportunity to study the use of orally administered paste prepared from Virola among the Bora and Witoto Indians of the area and to investigate plants and derivatives of plants in the fully equipped chemical laboratory on board. One of the projects undertaken by Phase VII constituted ethnopharmacological and chemical studies of various local species of Virola and, to a lesser extent, of the allied genera Iryanthera and Osteophloeum.

These studies are of interest, partly because the material analyzed was, in all cases, fresh, partly because some of the species studied had never been subjected to chemical investigation and partly because several of them were formerly employed by the Bora and Witoto Indians of the region in their magico-religious rituals and witchcraft.

The material collected during the 1977 Alpha-Helix expedition was preserved in a freezer (dark, −40° C) until analyzed. Most of these specimens of Virola were collected in the Río Ampiyacu and Río Yaguasyacu region and also near Pebas (Río Amazonas, Peru).

Reference Compounds

The reference compounds have been synthesized as described earlier (Agurell *et al.* 1969).

Isolation of Alkaloids

The powdered plant material (1 20 g) was extracted with methanol. After filtration and evaporation, equivalent amounts

of $CHCl_3$ and O,1-N HCl were added, and the organic layer was discarded after shaking. The aqueous layer was washed with $CHCl_3$ and was then made alkaline (pH = 9.0) with solid Na_2CO_3. The liberated organic bases were extracted with $CHCl_3$. The dried extract was dissolved in a suitable amount of mixture MeOH/ $CHCl_3$ (1:1) and submitted to TLC, GC and GC-MS analyses.

Thin-layer Chromatography (TLC)

Alkaloid constituents were separated on Silica Gel G TLC ready made plates (Merck No. 5748) with methanol-ammonia (99:1) as solvent. Alkaloids were located with Dragendorff's reagent and tryptamines with Erlich's reagent.

Gas Chromatography (GLC)

Gas chromatographic analysis was performed with two commerical apparatus (Pye Unical Model 104 and Schimadzu Model GC mini-1), equipped with hydrogen flame ionization detection systems.

The stationary phases used were:

1) 3% SE—30 ultraphase (1,50 m × 2.0 mm glass tube);
2) 3% OV –17 ultraphase (1,50 m × 2.0 mm glass tube);
3) SE—30 capillary WCOT column (25 m × 0.2 mm glass tube).

The columns were operated with temperature programming from 150° to 280° at 5°/min. rate. The injector block and the detector chamber were kept at 300°. For capillary column, a "solvent free" injection device was used (van den Berg and Cox 1972).

The amount of alkaloids in mg/100 g plant material and the percentage of each alkaloid in the alkaloid mixture was determined with the capillary column using DMT as a standard.

Gas Chromatography-Mass Spectrometry (GC-MS)

The principles of the technique have been described earlier (Holmstedt and Lindgren 1967). The mass spectrometry work was carried out with an LKB 2091 gas chromatograph-mass spectrometer. The ion source was at 270°, the electron energy was 70 e V and the electron ionization current 50 μA, respectively. The separations were made on columns consisting of 3% SE-30 and 3% OV-17 (2 m × 2.0 mm glass tube) with temperature programming.

List of chemical abbreviations used

DMT	=	N,N-Dimethyltryptamine
MMT	=	N-Methyltryptamine
T	=	Tryptamine
5-MeO-DMT	=	5-Methoxy-N,N-dimethyltryptamine
5-MeO-MMT	=	5-Methoxy-N-methyltryptamine
MTHC	=	2-Methyl-1,2,3,4-tetrahydro-β-carboline
6-MeO-THC	=	2-Methyl-6-methoxy-1,2,3,4-tetrahydro-β-carboline
6-MeO-DMTHC	=	1,2-Dimethyl-6-methoxy-1,2,3,4-tetrahydro-β-carboline

Comments on Chemical Constituents of Virola and Related Genera

Fifty-three voucher collections of Virola and related genera made by various botanists over a time span of several decades have been analyzed for alkaloids. Of the total number of collections, 18 proved negative when analyzed for alkaloids in various parts of the plant. Occasionally, different collections representing the same species have proven to be alkaloid-positive in some cases and negative in others. Four analyses of different collections of *Virola surinamensis,* however, all proved to be negative.

To our knowledge, only the bark and/or constituents of bark are used in the preparation of the intoxicating snuffs employed by the Indians. The alkaloid content of bark specimens is listed in Table 1, which also gives the species used in the manufacture of snuffs and the approximate alkaloidal content.

From this table, it is apparent that the species used are usually rich in alkaloids. *Virola rufula* is not known to be employed and, if it is not utilized, it would appear that the Indians have missed an alkaloid-rich species. In addition to the bark, the leaves and flowering shoots seem to be usually rich in alkaloids.

The simple alkaloids MMT, DMT, 5-MeO-MMT and 5-MeO-DMT abound in the species used; they are also present in other species.

The nyakwana snuff analyzed by Agurell *et al.* (1969) proved to be extraordinarily rich in base content (11%). This might explain

Table 1

Distribution of indole alkaloids in Virola sp. and related genera

Collection	Species	Part of Plant	Alkaloids: mg/100 g a) D. W. b) F. W.	Alkaloids	%
Schultes 24603	*Virola calophylla*[3] Manáos, Brazil	Bark	9 a)	DMT	91
				5-MeO-DMT	9
		Root	1 a)	DMT	87
				5-MeO-DMT	13
		Leaves	155 a)	MMT	4
				DMT	96
		Flowers Shoots	193 a)	MMT	4
				DMT	96
Plowman, Schultes & Tovar 6789	*Virola calophylla* Pebas, Peru (Alpha-Helix 1977)	Bark		DMT	
				MMT	
				MTHC	
Prance 14947	*Virola calophylla* Rio Cuieras, Brazil	Bark	9 a)	DMT	
				5-MeO-DMT	
		Root	1 a)	DMT	
				5-MeO-DMT	
		Leaves	115 a)	MMT	
				DMT	
Plowman, Schultes & Tovar 7093	*Virola calophylloidea* Pebas, Peru (Alpha-Helix 1977)	Bark	7.5 b)	DMT	50
				5-MeO-DMT	45
				5-MeO-MMT	5
Prance 14312	*Virola calophylloidea* Rio Curuquete, Brazil	Leaves	1.35 a)	DMT	100
Prance 14954	*Virola calophylloidea* Rio Cuieras, Brazil	Leaves	98 a)	DMT	100
Schultes & Rodrigues 26181a	*Virola carinata* Manáos, Brazil	Leaves	0.04 a)	DMT	100
		Bark			
		Twigs 1)			
Prance 13994	*Virola cuspidata* Rio Ituxi, Brazil	Leaves	neg. 2)		
Prance 15120	*Virola cuspidata* Rio Negro (middle course), Brazil	Leaves	neg. 2)		

Collection	Species	Part of Plant	Alkaloids: mg/100 g a) D. W. b) F. W.	Alkaloids	%
Schultes & Rodrigues 26115a	*Virola divergens* Manáos, Brazil	Leaves	0.5 a)	DMT	100
		Bark 1)			
Plowman, Schultes & Tovar 6595	*Virola elongata* Pebas, Peru (Alpha-Helix 1977)	Leaves	neg. 2)		
		Bark	neg.		
		Stem	neg.		
Plowman, Schultes & Tovar 6920	*Virola elongata* Pebas, Peru (Alpha-Helix 1977)	Phloem		T	
				DMT	
				MMT	
				MTHC	
				5-MeO-DMT	
				5-MeO-MMT	
		"Resin"		T	
				MMT	
				DMT	
				MTHC	
		Leaves	neg. 2)		
		Wood	neg.		
Plowman, Schultes & Tovar 7263	*Virola elongata* Pebas, Peru (Alpha-Helix 1977)	Paste		5-MeO-DMT	
				6-MeO-THC	
		Phloem		5-MeO-DMT	100
		Wood	neg. 2)		
Plowman, Schultes & Tovar 7092	*Virola elongata* Pebas, Peru (Alpha-Helix 1977)	Bark	3.2 b)	MMT	81
				DMT	14
				T	4
				5-MeO-DMT	trace
				5-MeO-MMT	trace
				MTHC	trace
Prance 15310	*Virola elongata* Tapurucuara, Rio Negro, Brazil	Leaves	19 a)	DMT	100
Plowman, Schultes & Tovar 7144	*Virola loretensis* Pebas, Peru (Alpha-Helix 1977)	Bark	neg. 2)		
Plowman, Schultes & Tovar . 259	*Virola loretensis* Pebas, Peru (Alpha-Helix 1977)	Bark	neg. 2)		

Table 1 (*continued*)

Collection	Species	Part of Plant	Alkaloids: mg/100 g a) D. W. b) F. W.	Alkaloids	%
Prance 11035	*Virola Melinonii* Rio Mucajaí, Roraima, Brazil	Leaves	neg. 2)		
Schultes & Rodrigues 26153a	*Virola Melinonii* Manáos, Brazil	Bark	0.18 a)	DMT	100
Schultes 24614	*Viola multinervia* 3) Manáos, Brazil	Bark	1 a)	DMT	100
		Root	1 a)	DMT	41
				5-MeO-DMT	59
Schultes 24616	*Virola multinervia* 3) Manáos, Brazil	Bark	1 a)	DMT	100
Schultes & Rodrigues 26151a	*Virola multinervia* Manáos, Brazil	Bark	neg. 2)		
Plowman, Schultes & Tovar 6682	*Virola peruviana* Pebas, Peru (Alpha-Helix 1977)	Bark		DMT 5-MeO-DMT 6-MeO-THC 6-MeO-DMTHC	
Plowman, Schultes & Tovar 6890	*Virola peruviana* Pebas, Peru (Alpha-Helix 1977)	Paste	27.6 b)	5-MeO-DMT 6-MeO-THC 6-MeO-DMTHC	99 trace trace
Plowman, Schultes & Tovar 6900	*Virola peruviana* Pebas, Peru (Alpha-Helix 1977)	Paste	1.73 b)	5-MeO-DMT	100
Schultes 24612	*Virola rufula* 3) Manáos, Brazil (Alpha-Helix 1967)	Bark	200 a)	DMT 5-MeO-DMT	4 95
		Root	144 a)	DMT 5-MeO-MMT 5-MeO-DMT	1 4 94
		Leaves	98 a)	MMT DMT	6 94
Prance 12308	*Virola sebifera* Serra da Moa, Acre, Brazil	Leaves	neg. 2)		

Collection	Species	Part of Plant	Alkaloids: mg/100 g a) D. W. b) F. W.	Alkaloids	%
Plowman, Schultes & Tovar 6198	*Virola surinamensis* Pebas, Peru (Alpha-Helix 1977)	Bark	neg. 2)		
Plowman, Schultes & Tovar 6619	*Virola surinamensis* Pebas, Peru (Alpha-Helix 1977)	Bark	neg. 2)		
		Leaves	neg. 2)		
		Seed	neg. 2)		
		Aril	neg. 2)		
Plowman, Schultes & Tovar 6684	*Virola surinamensis* Pebas, Peru (Alpha-Helix 1977)	Bark	neg. 2)		
		Leaves	neg. 2)		
Plowman, Schultes & Tovar 6775	*Virola surinamensis* Pebas, Peru (Alpha-Helix 1977)	Bark	neg. 2)		
		Paste	neg. 2)		
Schultes 24595	*Virola theiodora* 3) Manáos, Brazil (Alpha-Helix 1967)	Bark	250 a)	MMT	1
				DMT	52
				5-MeO-DMT	43
				5-MeO-THC	4
		Root	17 a)	DMT	22
				5-MeO-MMT	15
				6-MeO-DMT	62
		Leaves	44 a)	DMT	100
		Flowers	470 a)	MMT	7
		Shoots		DMT	93
Schultes 24626	*Virola theiodora* 3) Tototobí, Roraima, Brazil	Bark	65 a)	DMT	5
				5-MeO-DMT	95
		Leaves	21 a)	DMT	98
				MTHC	2
Schultes 24613	*Virola venosa* 3) Manáos, Brazil (Alpha-Helix 1967)	Bark	neg. 2)		
		Root	1 a)	5-MeO-DMT	100
		Leaves	1 a)	DMT	100
Plowman, Schultes & Tovar 7091	*Virola venosa* Pebas, Peru (Alpha-Helix 1977)	Bark	neg. 2)		
Plowman, Schultes & Tovar 7094	*Virola* sp. indet. aff. *venosa* Pebas, Peru	Bark	7.2 b)	5-MeO-DMT	58
				MMT	20
				5-MeO-MMT	16

Table 1 (*continued*)

Collection	Species	Part of Plant	Alkaloids: mg/100 g a) D. W. b) F. W.	Alkaloids	%
Plowman, Schultes & Tovar 7094	(Alpha-Helix 1977)			DMT	6
				T	trace
				6-MeO-THC	trace
				6-MeO-DMTHC	trace
		Leaves	14.7 b)	MMT	90
				DMT	8
				5-MeO-DMT	2
Schultes & Rodrigues 26188a	*Virola* sp. Manáos, Brazil	Leaves Bark Twigs 1)	0.22 b)	DMT	100
Schultes 26127	*Virola* n. sp. (?)	Leaves	0.07 a)	DMT	100
Schultes 26130	*Virola* sp.	Leaves Twigs 1)	neg. 2)		
Schultes & Rodrigues 26116	*Compsoneura Ulei* Manáos, Brazil	Leaves	neg. 2)		
Schultes & Rodrigues 26114	*Iryanthera coriacea* Manáos, Brazil	Leaves Bark Twigs 1)	neg. 2)		
Plowman, Schultes & Tovar 6919	*Iryanthera Ulei* Pebas, Peru (Alpha-Helix 1977)	Bark	0.013 b)	5-MeO-DMT	100
Plowman, Schultes & Tovar 7095	*Osteophloem platyplyllum* Pebas, Peru (Alpha-Helix 1977)	Bark	neg. 2)		
Schultes & Rodrigues 26126	*Osteophloem platyphyllum* Manáos, Brazil	Bark	0.62 a)	DMT 5-MeO-DMT 5-OH-DMT	
Prance 11117	*Osteophloem platyphyllum* Rio Mucajaí, Brazil	Leaves	neg. 2)		

1) The materials were mixed in a can containing alcohol.
2) Tested with Dragendorff and Ehrlich Reagents.
3) Published earlier by Agurell *et al.* (1969).

why the resin of *Virola theiodora* is also employed as an arrow poison. As has been pointed out by Gottlieb (1979) and as is evident from Table 1, there exist appreciable differences in the base composition of different parts of a single plant (Agurell *et al.,* 1969); this is true also of different species and even in analyses of different specimens representing the same species. When examining the data of Table 1 with respect to use, it must be kept in mind that the preparation of snuffs, pellets and arrow poison involves concentration of the resinous bark exudate to a thick syrup which is subsequently dried, powdered or rolled into pellets which are then coated with the residue of leachings from ashes. Such treatment, not to speak of storage, would be expected to alter the original base composition.

The hallucinogenic myristicaceous snuffs of the South American Indians owe their biological activity to the simple methylated indoles mentioned above (Holmstedt and Lindgren 1967; Agurell *et al.* 1969). Bufotenine, a component of the snuff made from *Anadenanthera peregrina* (Chagnon *et al.* 1971) is not present in the species of Virola investigated; neither is it present in the snuff made from them.

When analyzing Indian snuffs in 1967, Holmstedt and Lindgren noted the presence of harmala alkaloids in several preparations of uncertain botanical origin. In one case, both the simple indoles and harmine were present in the same preparation. This observation led to the following conclusion:

"In South American botany, β-carbolines (harmine, harmaline and tetrahydroharmine) are usually associated with the species of Banisteriopsis, wherefore it is very likely that this is their origin in the snuffs. Very likely this is an admixture to the snuff, although definite botanical proof for it is lacking at the moment. To the knowledge of the authors, simple indoles and β-carbolines have not yet been isolated *from the same plant*.

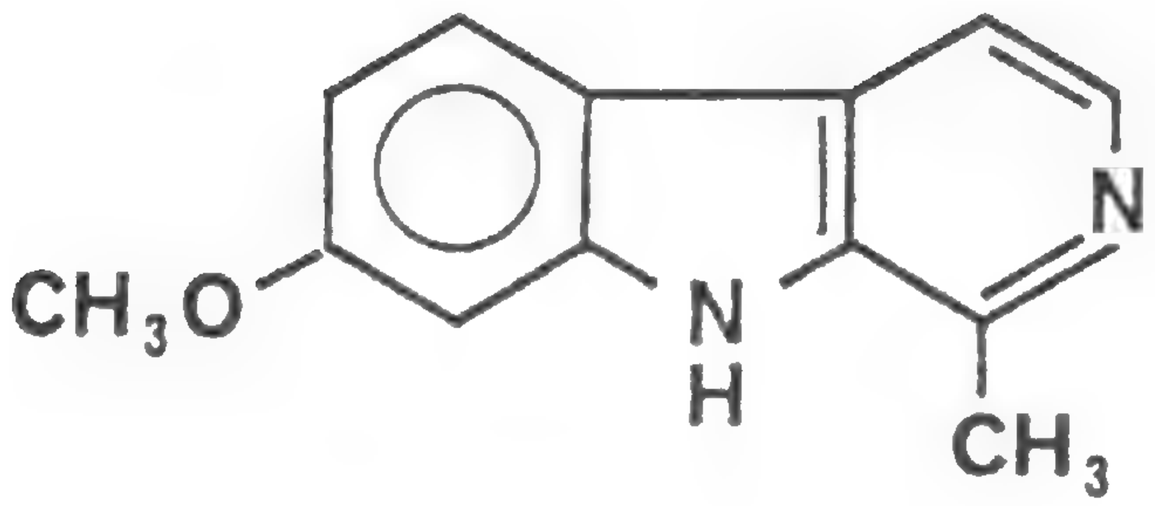
"The occurrence of both tryptamines and β-carbolines in the South American snuffs is pharmacologically interesting. The β-carbolines such as harmine and harmaline (Fig. 1) are monoamineoxidase inhibitors (Udenfriend *et al.* 1958) and could potentiate the action of the simple indoles. The combination of β-carbolines and tryptamines would thus be advantageous.

However, pharmacological action of the β-carbolines unrelated to monoamineoxidase inhibition has also been proven to exist (Schievelben *et al.* 1966). Further botanical and chemical studies are obviously needed to see if the two groups of compounds in the snuff are derived from one plant or a mixture of plants" (Holmstedt and Lindgren 1967).

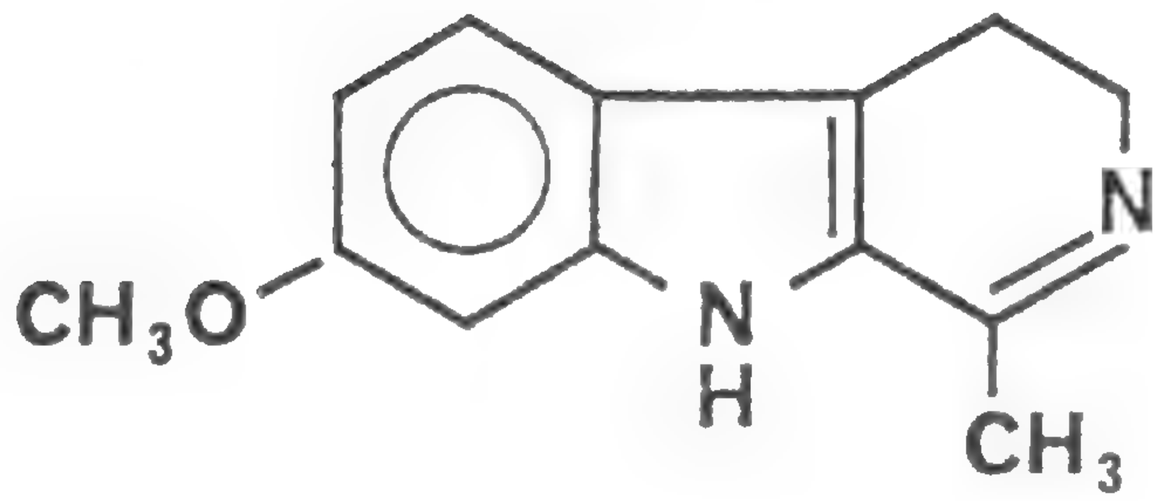
This observation has been often quoted and even misquoted. Additional phytochemical and enzymatic evidence is now available. Trace amounts of β-carbolines have been found to be present in *Virola calophylla, V. theiodora* and *V. elongata* (Fig. 2). In one species, which is not known to be used hallucinogenically, *Virola cuspidata,* harman bases have been found to be the main alkaloids (Fig. 3) (Cassady *et al.* 1971). Their existence has been unequivocally proven by isolation, spectroscopy and mass spectrometry, as compared to synthetic reference compounds. Interestingly, these authors have also observed aromatization due to heat treatment such as that practiced by the Indians when preparing snuff from other species. They also point out the possibility of increased potency of enzyme inhibition due to the aromatization.

Although the monoamineoxidase (MAO) inhibiting properties of harmine were observed indirectly before the enzyme was known to exist (Marinesco *et al.* 1930), it was only through Udenfriend and co-workers (1958) that these properties of the harmala alkaloids could be quantitated. Recently, the structure-activity relationship has been worked out for a large number of β-carbolines (Buckholtz and Boggan 1977). From this work, it is clear that the β-carbolines contained in *Banisteriopsis Caapi* and *Peganum Harmala* are far superior MAO-inhibitors than the compounds contained in usually trace amounts in Virola (Figs. 2 3). Table 2 (from Buckholtz and Boggan) gives a comparison of enzyme inhibitory power.

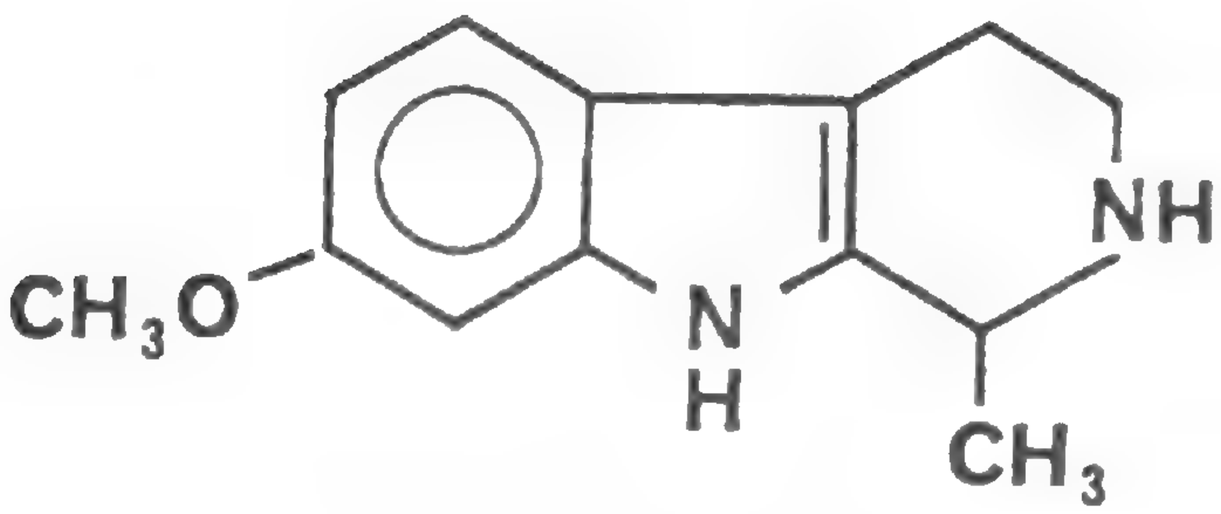
The occurrence of trace amounts of 6-methoxy-β-carbolines in some species of Virola (Table I and Fig. 2) is not surprising. It might be expected from the point of view of biosynthesis and workup procedure and is pharmacologically of no importance. The occurrence of a mixture of simple methylated indoles and harmine in one Indian snuff of unknown origin, or of harmine



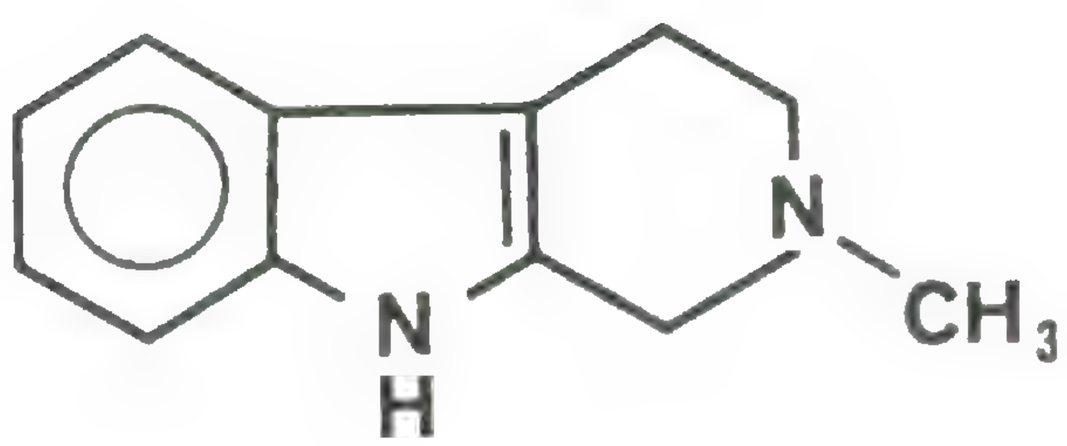
Harmine



Harmaline

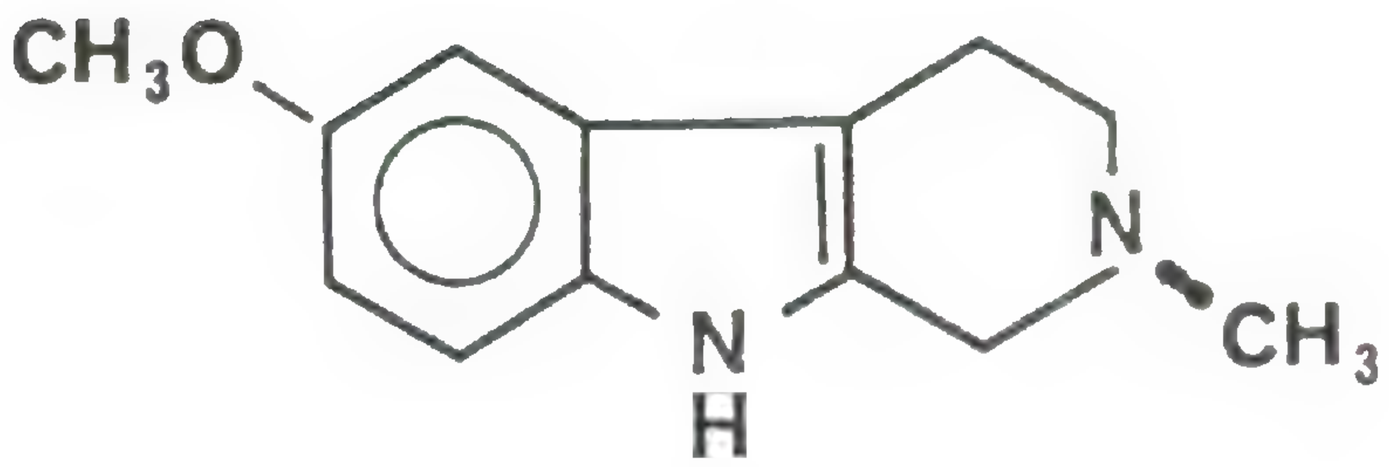


Tetrahydroharmine



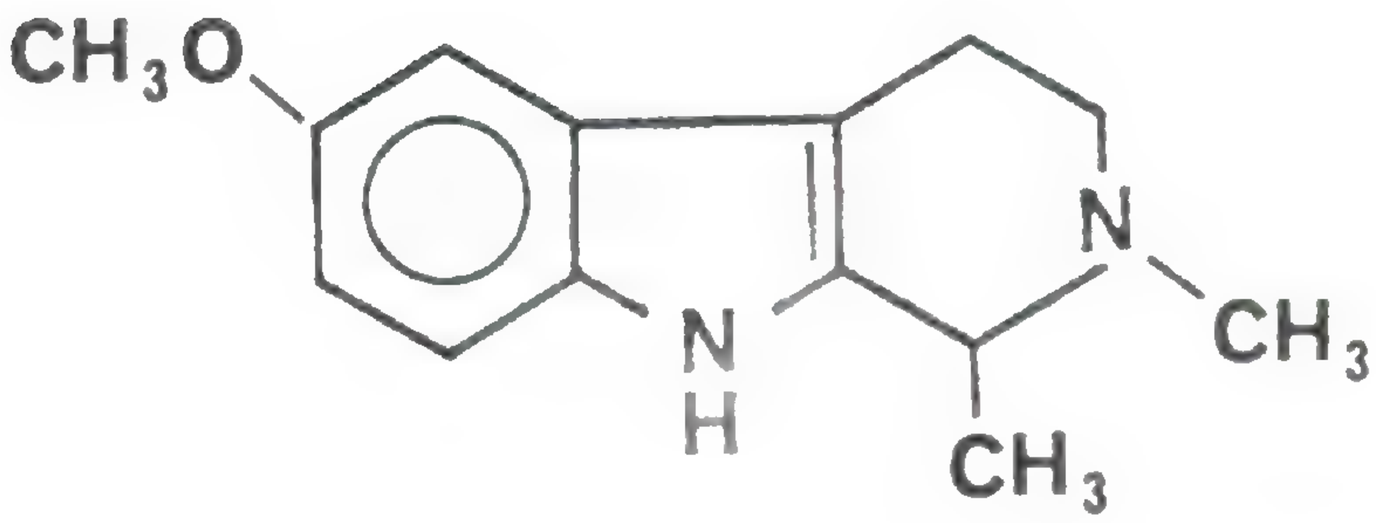
MTHC

2-Methyltetrahydro-
-β-carboline



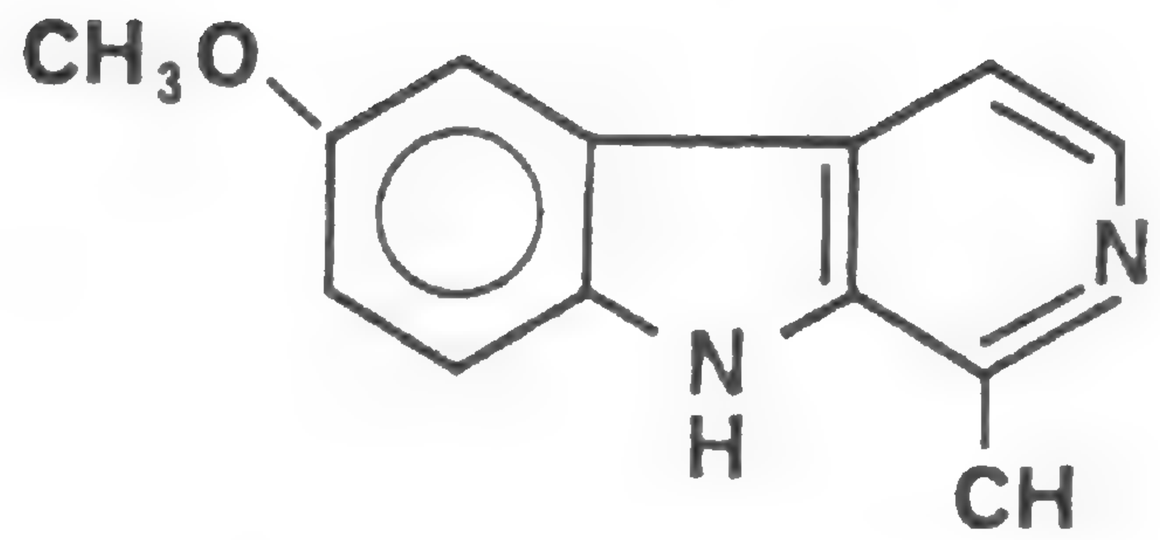
6-MeO-THC

2-Methyl-6-methoxy-
tetrahydro-β-carboline

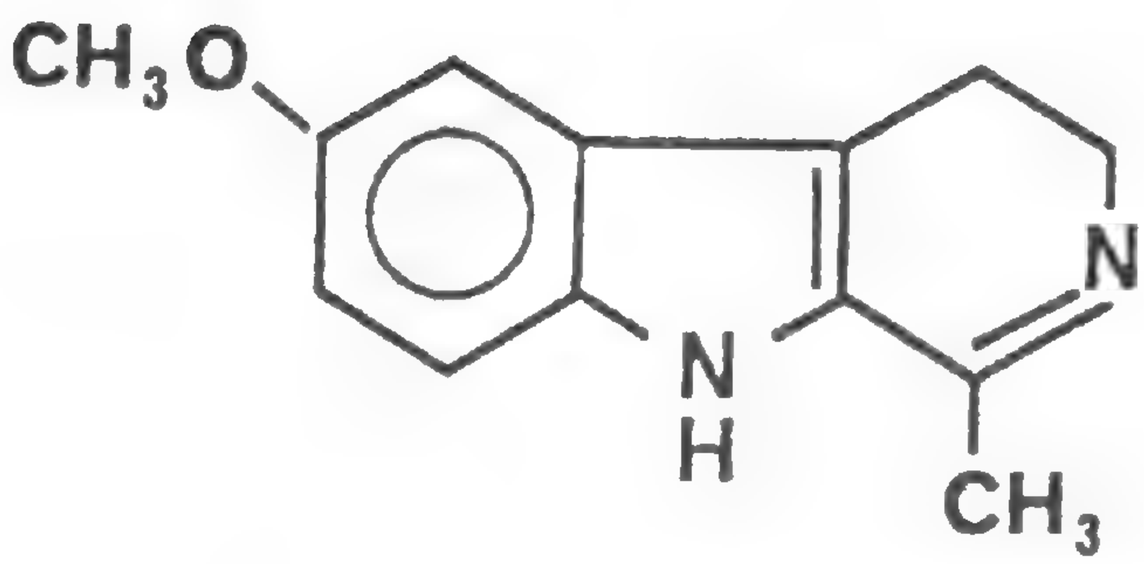


6-MeO-DMTHC

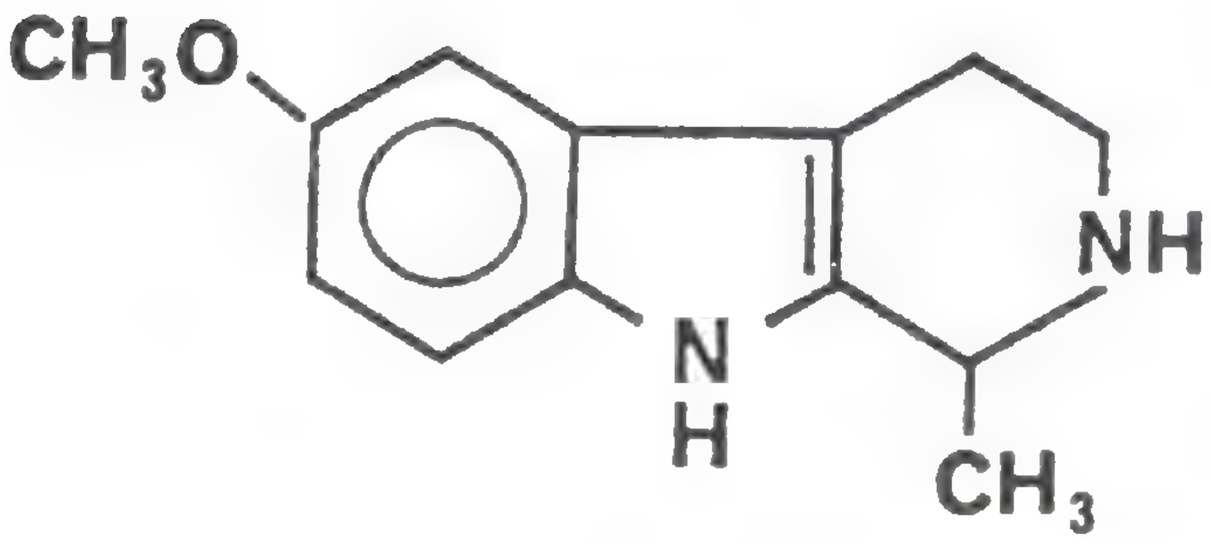
1,2-Dimethyl-6-methoxy-
tetrahydro-β-carbolines



6-Methoxyharmane



6-Methoxyharmalane



6-Methoxytetrahydro-
harmane

Table 2

In vitro inhibition by drugs of the deamination of tryptamine by mouse brain MAO

Drug	EC_{50}(M)
Harmine	8.0×10^{-8}
Harmaline	6.0×10^{-8}
Tetrahydroharmine	1.4×10^{-5}
6-MeO-THC	5.8×10^{-5}
6-MeO-Harmane	3.1×10^{-6}
6-MeO-Harmalane	1.8×10^{-5}
6-MeO-Tetrahydroharmane	4.2×10^{-4}

and related compounds alone in other snuffs, justifies, however, the statement made in 1967 and quoted above and should encourage further research on this interesting group of indigenous drugs and the plants from which they are derived.

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Iryanthera Ulei Warburg in Verh. Bot. Ver. Prov. Brand. 47(1905)137.
Myristica fragrans Houtt., Handleid 2(1774)333.
Osteophloeum platyspermum (A.DC.) Warburg in Nova Acta Acad. Leop.-Carol. 68(1897)162.
Virola calophylla Warburg in Nova Acta Acad. Leop.-Carol. 68(1897)231.
Virola calophylloidea Markgraf in Repert. Sp. Nov. 19(1923)24.
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Virola peruviana (A.DC.) Warburg in Nova Acta Acad. Leop.-Carol. 68 (1897)188.
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THE ETHNOBOTANY OF SWEET FLAG AMONG NORTH AMERICAN INDIANS

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The aromatic arum commonly known as Sweet Flag (*Acorus Calamus* L. of the Araceae) is an ancient and widely used medicinal plant. The plant's pungent-tasting rhizomes have been utilized as a medicine for many kinds of ailments, especially those relating to the respiratory and digestive systems. Also, many peoples have used the rhizomes as a tonic and stimulant, particularly Indian tribes of the western interior of North America. European peoples have employed the rhizomes as a flavoring agent in liquors, gin, beer and ice cream; they have also utilized the plant in perfumes, snuff and hair powder. New Englanders still continue to sugar and slice rhizomes for confectionary. Southern blacks used the rootstocks as a condiment; their consumption of the plant was mentioned in the classic folklore stories of "Uncle Remus" (Harper, 1936). Plains Indians were said to attribute mystic powers to Sweet Flag (Gilmore, 1919); the Pawnee mystery ceremonies included songs about Sweet Flag (Gilmore, 1919). In North Dakota, Calamus was used by Siouan shamans in a "holy dance" (*wakan wacipi*) (Howard, 1953).

Although the plant is usually called Sweet Flag, many other common names call attention to the sweet-smelling aerial stems or the aromatic rhizomes: Sweet Cane, Sweet Grass, Sweet Myrtle, Sweet Rush, Sweet Sedge, or Sweet Root. In 1860, Henry David Thoreau described the plant as having as agreeable and "peculiar frangrance" (Thoreau, 1860).

The aromatic stems and leaves of Sweet Flag inspired Walt Whitman to write a set of thirty-nine poems known as the "Calamus poems," which he included in his *Leaves of Grass* (3rd ed., 1860). Scented Calamus was strewn on church floors in

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sixteenth century England, and the plant was commonly spread on the floors of homes in colonial New England. The identifying scent has been helpful in distinguishing it from the poisonous Blue Flag (*Iris versicolor* L.). a marshy plant that resembles Sweet Flag in its vegetative stage.

The plant's widespread use among peoples of both the Old and New World is due partly to its cosmopolitan range in the Northern Hemisphere on the continents of Asia, Europe and North America. Although *Acorus Calamus* is a gregarious semi-aquatic plant restricted in habitat to the margins of fresh and brackish waters—swamps, marshes, bogs, ponds and rivers—it is able to live in a variety of climatic zones ranging from the tropics to the sub-arctic. The plant grows most abundantly, however, in the North Temperate Zone.

Man has increased the geographic range of *Acorus Calamus*. It was not native to Europe. European populations of *Acorus Calamus* do not bear fertile fruit: they remain sterile triploids ($2n = 36$) and propagate vegetatively by rhizomes. The nomadic Tartars had introduced the plant into European Russia by the thirteenth century (Buell, 1935); the "Mongolian Dragon" also introduced the plant into eastern Europe (Buell, 1935). According to Murray Buell, Tartars brought *Acorus Calamus* on the steppes of Russia because they drank water only when macerated with the rhizomes (Buell, 1935). Rhizomes were also introduced from southern Asia *via* Constantinople (Istanbul) into central Europe during the mid-sixteenth century (Mücke, 1908).

Most populations of *Acorus Calamus* east of the Appalachians are sterile. Some authorities believe that early seventeenth century colonists introduced it to the eastern seaboard from Europe. Experiments have shown that some populations in the Northeast are able to reproduce by seed; sterile clones may have resulted from selected rhizomes planted by colonists for medicinal and confectionary uses (Jervis and Buell, 1964). Possibly, the species is represented by both native and introduced strains along the Atlantic seaboard.

Populations of Sweet Flag in the interior of North America are fertile diploids ($2n = 24$), but Melvine R. Gilmore, a noted ethnobotanist, was unsuccessful in finding seed-producing

plants in the Central Plains (North Dakota to Oklahoma). He speculated that Indian medicine men planted Sweet Flag in the interior, observing that the plant was highly valued among Indian tribes, such as the Pawnee of Nebraska; and he commonly found the plant near former Indian village sites or near camping places along old Indian trails (Gilmore, 1931). In the early 1970's, Richard Full Bull, a Sioux, showed Kay Young an area of Sweet Flag on the Rosebud Reservation in south-central South Dakota. Full Bull claimed that his father had planted it there about 1900 (Young, 1980). An elderly Oglala Sioux, born in 1896, remembers that when her grandmother was alive (nineteenth century) some roots of Sweet Flag were transplanted to her reservation (Pine Ridge) in southwestern South Dakota from St. Charles in eastern South Dakota (Yankton Sioux country) (Chief, 1980). Although today Sweet Flag is rarely found growing at Pine Ridge, the roots are said to be more bitter and stronger than roots from eastern South Dakota (Chief, 1980). The Oglala Sioux obtain most of their supply of Sweet Flag from Siouan tribes of central and eastern South Dakota, notably the Brule, Santee, Yankton and Sisseton.

The inter-tribal trade price of the plant is rather high: an Oglala Sioux payed as much as $5.00 for a piece of root two inches in length (Good Shield, 1980). The Northern Cheyenne of Montana have also obtained the roots of Sweet Flag from the Sioux (Grinnell, 1923).

The muskrat (*Ondatra zibethica*), a ubiquitous semiaquatic rodent native to North America, might have played an important role in the propagation of Sweet Flag. The muskrat has a voracious appetite for the plant, especially for its rhizomes. The animal's eating habits may have increased the geographic range of the plant. When food is abundant, the muskrat is wasteful; scraps of plant parts are left behind on "feeding platforms" (Takos, 1947). The Canadian biologist, Michael Sarrazin, who pioneered in anatomical studies of the muskrat, believed that the special musky odor from the musk glands resulted from the animal's abundant nourishment of *Acorus Calamus* (Vallée, 1927).

Muskrat furs constituted an important trade item for the Indian. The fecund muskrat was an economic mainstay of the

Hudson Bay Company (1670–1873); the dyed and plucked fur, known as "Hudson seal," increased the animal's value. Although the beaver pelt was the most prized, it was exhaustible. Female beavers bear annually only one litter of four. By contrast, the female muskrat is prolific, able to produce up to five litters a year, each litter normally with eleven offspring (Ray, 1975).

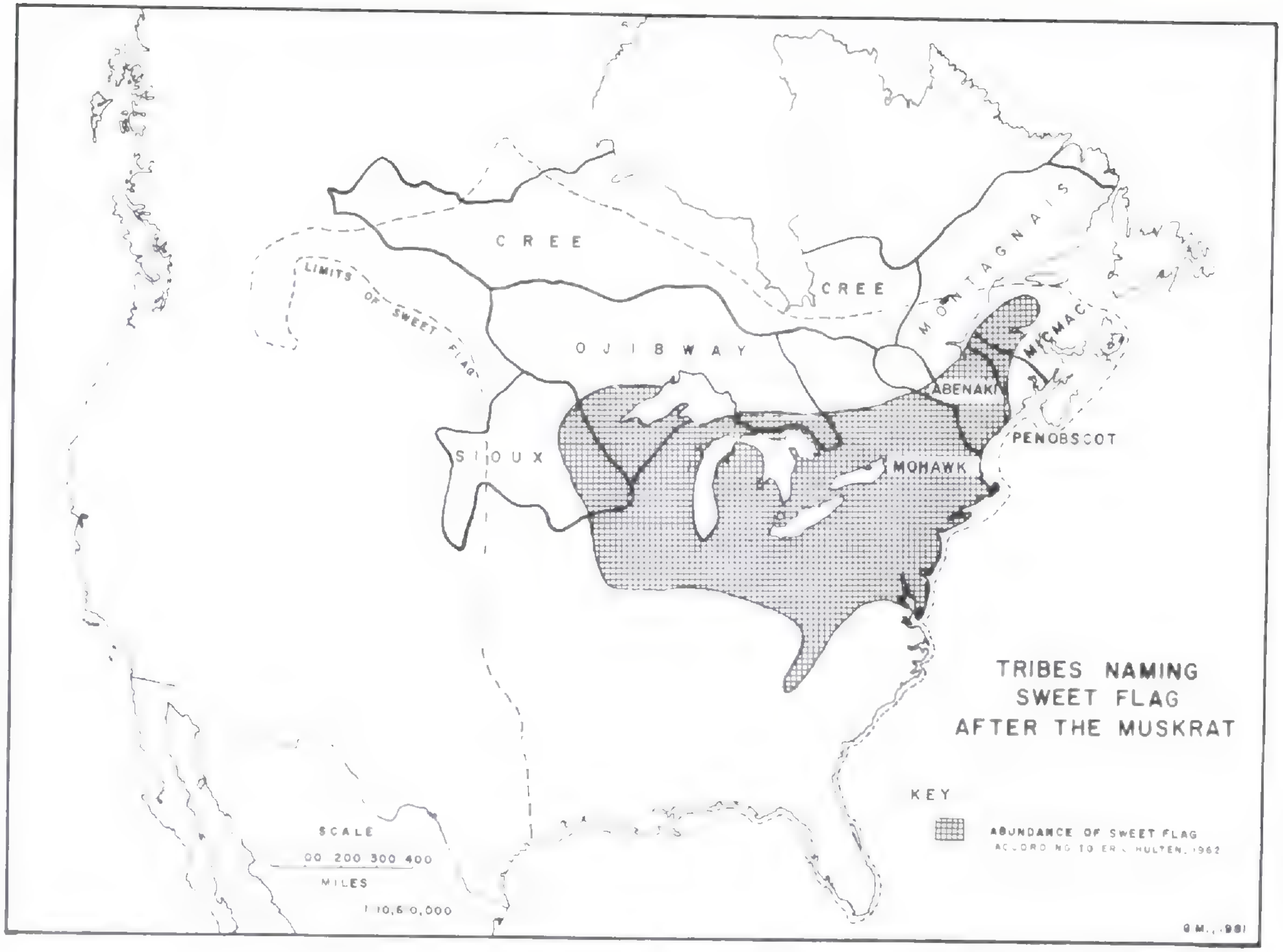
Hudson's Bay Territory was largely conterminous with Canada's Laurentian Shield, a boreal forest country with hundreds of fresh water lakes, an ideal habitat for Sweet Flag and the muskrat. Much of this vast wilderness was the territorial hunting land of Algonquian tribes, especially of the Cree and Ojibway.

While on long hunting expeditions, the Cree chewed Sweet Flag rhizomes as a stimulant against fatigue and for endurance. In 1892, R. Strath visited Norway House, a former fur trade centre of Hudson Bay Company, located about 400 miles north of Winnipeg. His observations of the plant among the Cree are interesting:

> Large bundles of this plant can be seen hanging in every tepee or wigwam, tent or house wherever Indians are found, and seems to be the family medicine of the people, its virtues being known to all....A piece of root is carried by every tripper on his hunts and trips for the Hudson Bay Company and when feeling exhausted by hunger or fatigue, a small piece slowly chewed will restore the flagging energies in a most wonderful manner (Strath, 1903).

The Indian may intentionally have propagated *Acorus Calamus* not for medicine alone but to insure a future supply for the muskrat upon which their livelihood depended. Thus, the fur trapping Indian, the muskrat, and Sweet Flag may have constituted a complementary interlocked ecologic system in the northlands.

Extending across an immense territory, from maritime Canada and New England to the upper Great Lakes, Alberta and the Dakotas, the plant was named after the muskrat by several Indian tribes. The word muskrat originates from the Algonquin word musquash (Natick dialect). The following tribes have called the plant "muskrat root" or "muskrat food": *Algonquian language stock*—the Abnaki of New Brunswick and Maine, *moskwas'wask* (Rousseau, 1946–48); Micmac-Montagnais of Newfoundland, *ki we swask* (Speck, 1917); Penobscot of Maine, *muskwe s uwesk* (Speak, 1917); Cree near Hudson Bay, *weekas*


CREE
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LIMITS OF SWEET FLAG
OJIBWAY
MICMAC
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PENOBSCOT
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(Strath, 1903), *wekas* (Flexon, 1897–1898), and *watchuske mitsu in*, "that which the musk rat eats" (Franklin, 1854); Chippewa (Ojibway) of Minnesota-Ontario, *wiken* (Densmore, 1928), and Chippewa of Ontario-Michigan, *wika* (Gilmore, 1933); *Iroquoian language stock*—the Mohawk of New York State, *anotion ao-titara* (Rousseau, 1945); *Siouan language stock*—the Dakota Sioux, Minnesota and the Dakotas, *si*^{n} *kpe-ta-wote* (Gilmore, 1919).

A Penobscot Indian dreamed that the "muskrat spirit" was the "muskrat root":

> The muskrat told him that he was a root and where to find him. The man awoke, sought the muskrat root, made a medicine of it, and cured the people of the plague. (Speck, 1917).

The Penobscot believed that they would be cured of cholera by utilizing Sweet Flag; observing that muskrats eating the plant had meager excrements, they believed that the effects would be the same for them (Speck, 1917).

The occurrence of the name "muskrat root" or "muskrat food" among different tribes of three language families strongly suggests diffusion. The fact that these tribes were contiguous strengthens the case for diffusion. Furthermore, Europeans may have aided in the dissemination of the animal's name in the fur trade, the British calling the animal *musquash* (later muskrat), the French using the term *rat musqué*.

Sweet Flag has been considered a panacea medicine among culturally diverse Indian tribes, such as the Cheyenne, Dakota, Micmac and Mohegan. Many tribes have employed *Acorus Calamus* as an expectorant and febrifuge for curing the common cold. The Chippewa snuffed Sweet Flag for colds (Densmore, 1928). For colds and bronchial problems, the Chippewa also mixed Sweet Flag with the bark of *Xanthoxylon americanum* Mill., bark roots of *Sassafras variifolium* (Salisb.) Ktze., and the roots of *Asarum canadense* L. (Gilmore, 1933). For colds, the Dakota, Omaha, Winnebago and Pawnee chewed the root or made an infusion (Gilmore, 1919); for colds, they also used the smoke treatment—breathing fumes of the plant under a blanket from the root shavings or powder sprinkled on live charcoals. Among the Swampy Cree, Sweet Flag has been an important medicine for curing various throat troubles:

> It is considered a specific in all throat troubles .... In the case of pharyngitis it is used externally and internally. The rhizome is chewed and the saliva allowed to wash the throat. Poultices are made by mixing the powder with boiling water. (Flexon, 1897).

Among the Iroquois, Sweet Flag has been valued as an aid for singing at ceremonials or pow-wows (Fenton, 1942). The Sioux still use Sweet Flag when they sing at ceremonials or pow-wows (Elk Boy, 1979; Primeaux, 1979). They place a small piece of the root in the mouth; the juices of the root are said to keep the throat clear while singing. Sweet Flag was also used by Europeans to clear the throat:

> When the rhizome is masticated, it is said to clear the voice, and it is sold by herbalists for this purpose ... (Bentley, 1880).

Indians, especially those of hunting cultures, employed Sweet Flag as a carminative, emetic and cathartic for relief of gastro-intestinal discomforts. For example, the Abnaki of New Brunswick drank a warm decoction of Sweet Flag as a carminative to relieve stomach gas (Rousseau, 1946–1948). Because of irregular eating, due partly to dietary customs as well as lack of food, intestinal problems were common among peoples of the hunting economy:

> Digestive disturbances were frequent due to two conditions. First, spells of semi-starvation alternated with periods of abundance, during which they grossly overate. Second, it was the custom on hunting and war parties, or when the village was moving through hostile country, to abstain from food, not infrequently for several days at a time. These fasts were broken by an orgy of feasting (Stone, 1932).

The diet and eating habits of the contemporary Indian are generally poor. The prevalence of alcoholism is a major cause of semi-starved families; the diet is largely one of greasy food. Among the Sioux, for example, Sweet Flag is still commonly used to relieve gastro-intestinal disturbances.

Acorus Calamus was commonly employed as an analgesic. Several tribes applied Sweet Flag as toothache medicine, notably the Cree (Osmund, 1967), the Chippewa (Densmore, 1928), and the Sioux, Omaha, Pawnee, and Winnebago (Gilmore, 1919). The Cree also valued the plant to relieve headaches (Osmund, 1967); Resident Nurse, 1943); the Sioux breathed in

the burned fumes of the plant to cure headaches (Bear Killer, 1980; Lame, 1981).

Cree women were known to use an infusion of *Acorus Calamus* tea for the discomfort of dysmenorrea (Strath, 1903). Among the Winnebago, women mixed Sweet Flag (*man' a[n] kera' xera)* with six other plants in water; when thoroughly mixed, the preparation was injected into the bladder with a wing bone (Radin, 1923).

Oklahoma Delaware women used the rhizome to suppress menses (Tantaquidgeon, 1942). Menominee women ground the rhizome with bloodroot (*Sanguinaria canadensis* L.) and pieces of cedar wood as a remedy for irregular menstruation (Densmore, 1932). The Blackfoot of western Montana are said to have employed Sweet Flag to cause abortion (Johnston, 1970).

Several tribes have used Sweet Flag as an external medicine. The Meskwaki rubbed the plant on burns (Smith, 1928). An elderly Sioux rubbed the plant on sores or places where the body hurts: "People also put it on an open sore and then bandage it" (Left Hand, 1980). An eighty-year-old Sioux woman claimed that she relieved the effects of a stroke by rubbing her face with a salve of Sweet Flag and grease (Good Shield, 1980).

Sioux warriors chewed rhizomes to a paste which they smeared on their face to prevent fear in the presence of the enemy (Gilmore, 1919). But the juice swallowed by the warriors was perhaps more important for their needs than the smear of facial paste. At the battlefront, descendents of Sioux warriors chewed the plant in both World Wars and in the Korean and Viet Nam conflicts; it was thought to instil fearlessness and enhance endurance (Bear Killer, 1979). A Sioux indicated that muskrats are fierce and "afraid of nothing" because the animal eats Sweet Flag; thus, the plant would make a man fearless (Bear Killer, 1979).

The Sioux administered Sweet Flag to dogs to make them fierce watchdogs. They would give a puppy an infusion of tea from a boiled root or spit the masticated root of the plant into the puppy's mouth; after doing this two or three times, the puppy would grow up to be "mean" and a good watchdog protecting the family (Bear Killer, 1979; Good Shield, 1980).

The Cheyenne and the Sioux considered Sweet Flag to be an amulet. To keep away night spirits, Cheyenne children had a piece of the root tied to their necklet or blanket (Grinnell, 1923). The Sioux used the "smoke treatment" to "chase away ghosts" (Bull Man, 1980). An elderly Sioux woman gave an interesting account of Sweet Flag being utilized to drive away evil spirits:

> My grandmother's son lived in a haunted house. He locked the door but it would open at night and there would be a strong wind even though it was quiet outside. Fifty years ago my grandmother told me that it (Sweet Flag) was good for haunted houses. Grind up the root and burn and smoke all the rooms to drive away spirits. My son did it and it worked. The door never opened again. (Chief, 1980).

Even today, many elderly Sioux carry a piece of the rhizome with them as an amulet.

Some tribes not only took Sweet Flag as a tonic for themselves but would give it to horses to make them spirited and run faster. The Omaha gave the plant as a snuff to horses (Grant, 1980); the Oglala and Yankton Sioux administered an infusion of Sweet Flag to race horses (Elk Boy, 1979; Primeaux, 1979). When Peyote (*Lophophora williamsii* (Lem.) Coult.) was adopted by the Yankton Sioux in the earlier part of this century, however, they gave their race horses an infusion of Peyote (Primeaux, 1979).

Smith reported an unusual use of *Acorus Calamus* by a Flambeau Ojibwe Indian, Big George, who soaked a gill net in an infusion of Sweet Flag and Sarsaparilla to make a "fine catch" of white fish (Smith, 1932); Smith relates that the fish net "still smelled of Calamus root after being in the water more than twelve hours..." (Smith, 1932).

An informant of Hoffer and Osmund, who lived among the Cree of northern Alberta, experimented with large doses of Sweet Flag. On five different occasions, the informant and his wife chewed ten inches of the rhizome; each time, they had an experience similar to that induced by LSD (Hoffer and Osmund, 1967). Since both the informant and his wife (a psychiatric nurse) had taken LSD several times under controlled conditions, they were perhaps preconditioned physiologically and psychologically to have such a similar experience. The quantity that each

informant had taken was ten times the amount normally taken by the Cree for anti-fatigue (Hoffer and Osmund, 1967). Sweet Flag may be hallucinogenic in larger quantities: Indians possibly took the plant for that purpose, since they were careful to consume only small quantities when it was used as a medicine. The prescribed amount of the rhizome eaten by the Chippewa was the length of an index finger (Densmore, 1928); Smith reported that the Chippewa took no more than one and a half inches (Smith, 1932); the Forest Potawatomi were "cautious" of the amount they used, believing that only a "very small piece" was necessary (Smith, 1933); the Menomini consumed no more of the rhizome than the length of a finger joint, because they considered the plant to be a powerful medicine (Smith, 1923); the amount taken by an adult Cree in a mid-nineteenth-century report was about the "size of a small pea" (Franklin, 1854). If the plant is proven to be hallucinogenic, it is quite possible that earlier generations of Indians knew of that effect and that later generations lost the knowledge. Indians of former times may have known that larger amounts of the plant would alter states of consciousness. To date, chemical investigations suggest that α-asarone and β-asarone are the active principals in Sweet Flag. Although mescaline and asarone are structurally similar, their biological effects differ; asarone is not known to be truly hallucinogenic (Schultes and Hofmann,1980).

Sweet Flag continues to be an important medicinal plant among various Indian tribes, although it is now more often used by the older generation. The revival of interest in the preservation of traditional ways of life, as shown by the younger Indians within the last decade, perhaps insures a continued use of the plant as a medicine.

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BOTANICAL MUSEUM LEAFLETS
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DE PLANTIS TOXICARIIS E MUNDO NOVO TROPICALE COMMENTATIONES XXVII

FOLK USES OF COLOMBIAN SPECIES OF BRUNELLIA AND WEINMANNIA

RICHARD EVANS SCHULTES

Amongst the characteristic trees and shrubs of the Colombian Andes are species of Brunellia and Weinmannia of the Brunelliaceae and Cunoniaceae, respectively. Notwithstanding their abundance in many localities, they do not appear to have been widely used in native medicine and consequently have not generally been considered as biodynamic plants. In view of the sparsity of ethnopharmacological information, the following few notes may be of interest and perhaps will serve to stimulate further ethnobotanical investigations and encourage phytochemical research.

The collections cited are preserved in the Gray Herbarium and the Economic Herbarium of Oakes Ames, both at Harvard University, and in the Herbario Nacional Colombiano in Bogotá. I wish to acknowledge the help of Dr. José Cuatrecasas of the Smithsonian Institution who has either identified or checked the identification of the material on which the following notes are based.

Brunellia and Weinmannia belong to two related rosalian families: Brunelliaceae and Cunoniaceae, respectively. The former family is monotypic, with under 50 species native to the New World, from Mexico to Peru and the West Indies; the latter, with about 25 genera and 250 species, is widespread in the Old World tropics and, with Weinmannia, is well represented with about 170 Andean species from Mexico to Chile. Both Brunellia and Weinmannia are well represented in the Colombian highlands.

The Cunoniaceae are chemically not well investigated (Hegnauer, R.: *Chemotaxonomie der Pflanzen* 3 (1964) 626). This lack of understanding is due probably to the sparsity of notes on

native uses which have concentrated primarily on the utilization of the wood of several species.

Virtually no chemical studies on any of the Colombian species of Weinmannia have apparently been reported. Nor have medicinal uses been noted for representatives of this genus in the northern Andes (Perez-Arbeláez, E.: *Plantas Utiles de Colombia* (1956); Perez-Arbeláez, E.: *Plantas Medicinales y Venenosas de Colombia* (1975); García-Barriga, H.: *Plantas Medicinales de Colombia* (1974)).

Tannins appear to be common in the bark and leaves of all species investigated (Gibbs, R. D.: *Chemotaxonomy of Flowering Plants* 2 (1974) 769). An African species of Cunonia *C. capensis* L.—has a high concentration in its wood (Hegnauer: loc. cit.).

The bark of several species of Weinmannia valued in Africa and South America in tanning. The bark of *W. pinnata* L. has a very astringent bark and excretes a gum used in Cuba as an adulterant of quinine. Similarly, the bark of *W. Selloi* Engl. is notably astringent and is employed in Brazil to treat wounds (Uphof, J. C. T.: Dictionary of Economic Plants (1968) 550). It is interesting to note that several of the native uses reported below for Colombia may be related to the astringency of Weinmannia.

Coumarin and the triterpenoids epifriedelinol and friedelin are reported from Ceratopetalum, a cunoniaceous genus, and the flavonol kaempferol occurs in *Cunonia capensis* (Gibbs: loc. cit. 1 (1974) 444, 589; 2 (1974) 848, 850). Aluminum accumulation is common in some species of the Cunoniaceae (Gibbs: loc. cit. 3 (1974) 1647).

The Brunelliaceae are chemically even less known than the Cunoniaceae (Hegnauer: loc. cit. 306; Gibbs: loc. cit. 3 (1974) 1616). Two Colombian species of Brunellia –*B. comocladifolia* Tul. and *B. Steubelii* Hieron., both known vulgarly as *yuco riñón* —are reputedly valued as febrifuges (Perez-Arbeláez: loc. cit. 243).

Brunelliaceae

Brunellia colombiana *Cuatr.* in Rev. Acad. Col. Cienc. 5(1942) 33, fig. 20–22.

Colombia: Departmento de Cundinamarca, Páramo de Guasca. Alt. 2850–3340 m. January 22, 1942. *R. E. Schultes et R. Jaramillo M. 3205x.*

Peasants living in the high páramos near Bogotá are careful not to utilize the wood of *Brunellia colombiana* in kitchen fires in their small huts, maintaining that the smoke is irritant and over a long period causes the growth of "a film" (cataract?) over the eyes. The vernacular name of *Brunellia colombiana* is reported as *jobo.*

Brunellia sibundoya *Cuatr.* in Rev. Acad. Col. Cienc. 5 (1942) 35.

Colombia: Comisaría del Putumayo, Valle de Sibundoy, hills north of Sibundoy. Alt. c. 2250 m. "Tree up to 30 feet tall." February 12, 1942. *R. E. Schultes 3202.*—Same locality July 19, 1963. *M. L. Bristol 1247.*

The Kamsá Indians of Sibundoy refer to this tree as *maní* and *tsubojush*. They prepare a tea of the leaves with the mucilaginous fruits of *Saurauia brachybotrys* Turcz. (*Schultes 3203*), known locally as *moquillo* in Spanish, *je-nuss* in Kamsá, to be ingested as hot as possible in treating pulmonary congestion in influenza and pneumonia.

The bark of *Saurauia brachybotrys* has another medicinal use in Sibundoy. The bark, rasped and powdered, is applied to sores "to extract the pus."

Cunoniaceae

Weinmannia Balbisiana *HBK.* var. **lamprophylla** *(Diels) Cuatr.* in Lloydia 11 (1949) 201.

Colombia: Comisaría del Putumayo, Valle de Sibundoy, vicinity of Sibundoy. Alt. c. 2250 m. February 18, 1942. *R. E. Schultes 3277.*

The resinous leaves of this tree are vigourously rubbed on limbs by the Kamsá Indians of the Valle de Sibundoy for relief of rheumatic pains.

Weinmannia Balbisiana *HBK.* var. **laurina** (HBK.) *Cuatr.* in Lloydia 11(1949) 201.

Colombia: Comisaría del Putumayo, Valle de Sibundoy. "Tree 6 m.; filaments styles white, ovary becoming red." June 12, 1963. *M. L. Bristol 1116.*

This tree is infrequently cultivated in gardens by the Kamsá Indians. The Kamsá name is *batetsmuske*; in Spanish, it is known as *encino*.

Weinmannia cochensis *Hieron.* in Engler, Bot. Jahrb. 21 (1895) 310.

COLOMBIA: Comisaría del Putumayo, Páramo de San Antonio, between La Cocha and Sibundoy. Alt. c. 3000–3200 m." Medium tree. Flowers white, buds red. February 12, 1942. *R. E. Schultes 3231a.* Same locality and date. Schultes 3249. Same locality. June 1, 1946. *R. E. Schultes et M. Villarreal 7813.*— Same locality. March 13, 1953. *R. E. Schultes et I. Cabrera 18845.*

The natives of this highland region know *Weinmannia cochensis* as *encino* or *encino de páramo*.

Weinmannia Engleriana *Hieron.* in Engl. Bot. Jahrb. 20, Beibl. 49 (1895) 24.

COLOMBIA: Comisaría del Putumayo, road from Sibundoy to Pasto: between Laguna La Cocha and Páramo del Tábano. Alt. c. 2800 3000 m. "Low tree, semi-bushy. Fruits red." June 1, 1946. *R. E. Schultes et M. Villarreal 7778.* Departamento de Nariño, Volcán El Galeras. Alt. c. 3200 3500 m. June 4, 1946. *Schultes et Villarreal 8002.*

The Kamsa Indians of Sibundoy ascribe antirheumatic properties to the leaves of this small tree.

Weinmannia pubescens *HBK.* var. **popayanensis** *(Hieron.) Killip et Smith* in Bull. Torr. Bot. Club 56 (1929) 376.

COLOMBIA: Comisaría del Putumayo, Valle de Sibundoy, hills north of Sibundoy. Alt. c. 2250 m. *"Encino."* February 12, 1942. *R. E. Schultes 3211.* Departamento de Nariño, highway between Santa Rosa and Túquerres. Alt. c. 2750 2850 m. "Bush about 12 feet. Flowers white." *R. E. Schultes et M. Villarreal 7904.*

In the Valley of Sibundoy the leaves of this bush are rubbed on painful joints to reduce inflammation.

Weinmannia silvatica *Engl.* in Engler et Prantl, Nat. Pflanzenf. 2, Aufl. 18a (1930) 252.

COLOMBIA: Comisaría del Putumayo, Páramo de San Antonio, between La Cocha and the Valle de Sibundoy. Alt. c. 3000 3200 m. "*Encino; encino blanco.* Large tree. Flowers white." February 13, 1942. *R. E. Schultes 3230.*— Road from Sibundoy to Pasto: between La María and Páramo de San Antonio. Alt. 2900 3180 m. "Large tre 60 feet. Flowers red." June 1, 1946. *R. E. Schultes et M. Villarreal 7554.* –Páramo de San Antonio. Alt. 9300 9600 feet. March 13, 1953. *R. E. Schultes et I. Cabrera 18894.*

Departamento de Nariño, Pasto, near base of Volcán El Galeras, above town of Ibonuco. Alt. c. 2700 2950 m. June 4, 1946. *Schultes et Villarreal 8020.*

In the Valley of Sibundoy, the wood of the tree is valued for fuel and construction. One medicine man indicated that a tea prepared by boiling the flowers served as an astringent wash for open wounds and that this treatment helped hasten healing.

Weinmannia Trianaea *Wedd.* var. **sulcata** *(Engl.) Cuatr.* in Lloydia 11 (1943) 205.

COLOMBIA: Comisaría del Putumayo, Páramo de Tambillo, northeast of the Valle de Sibundoy. Alt. 2700 2800 m. December 13 14, 1942. *R. E. Schultes et C. Earle Smith 3119.*

The Indians of Sibundoy value this plant as a medicine. Crushed and passed through warm water, the leaves of *Weinmannia Trianaea* are poulticed on open wounds. This same preparation is massaged on swollen and painful joints to reduce rheumatic inflammation. The plant is known locally as *encín* in Spanish and *shajanaka* amongst the Kamsá Indians.

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CHAMAIRO: *MUSSATIA HYACINTHINA*— AN ADMIXTURE TO COCA FROM AMAZONIAN PERU AND BOLIVIA

TIMOTHY PLOWMAN

INTRODUCTION

The custom of chewing coca, whether whole coca leaves in the Andes or pulverized coca in the Amazon, is a relatively well known practice (Plowman, 1979, 1981). However, very little has been written about the numerous admixtures employed in coca chewing or about the plant masticatories employed as coca substitutes.

Coca-chewing peoples in different ecological zones have discovered many alkaline source materials which serve to "sweeten" and potentiate the coca quid, apparently by increasing the absorption of the alkaloids by the mucous membranes (Rivier, 1981). The alkaline substances habitually added to the coca quid are derived from mineral (limestone, clay), animal (bones, sea shells) or vegetable (plant ashes) sources. The particular materials used and their preparation vary greatly from region to region, and some preparations may be very local.

The vegetable sources of alkali which serve as coca admixtures include the following: ashes of leaves (*Cecropia* spp., *Pourouma* spp., palms), stems (*Vernonia* sp.), bark (*Styrax anthelminticum* R. E. Schult.), roots (*Vicia faba* L., *Musa* × *paradisiacum* L.), fruits (*Theobroma Cacao* L., *Trichocereus* sp.), infructescenses (*Zea Mays* L.) or whole plants (*Chenopodium Quinoa* Willd., *C. pallidicaule* Aellen, *C. ambrosioides* L.). Unfortunately, we still know very little about the chemical compositions of the ash residues of these plant materials, about their preparations for coca chewing or about their pharmacology in the mouth. Only two studies have considered in depth

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the chemical composition and function of these alkaline additives (Cruz Sánchez & Guillén, 1948; Rivier, 1981).

Plants or plant derivatives may also be added to coca to lend flavor or sweetness. In northern Peru, dried leaflets of *misquina* (*Abrus precatorius* L.) are added as a licorice-flavoring to coca; in southern Peru, the foliage of *pampa anis* (*Tagetes pusilla* HBK.) is chewed with coca or alone against the cold (Fisher, 1976). In the upper Amazon, tobacco paste or powder is frequently taken with the powdered coca characteristic of the region (Plowman, 1981). In the Colombian Vaupés, coca powder is sometimes flavored with the aromatic smoke of burning *brea*, the resin of *Protium heptaphyllum* March (Schultes, 1957).

A related topic of interest includes the plants which are employed as coca substitutes. These plants are used primarily when coca chewers exhaust their supplies of coca leaf or coca powder. Although there are probably many such plants which remain undiscovered, about a dozen have been identified to date. Of these, a few are still known only by local vernacular names and have not been botanically identified. In the high Andes, the leaves of *Dodonaea viscosa* L. (Greenish, 1904) and the foliage of *Werneria dactylophylla* Sch. Bip. (Hemsley, 1907) may be chewed. The latter is chewed to resist the cold. At lower elevations in the Andean foothills of Peru, the Campa Indians chew the leaves of *Cordia nodosa* L., a well known myrmecophyte called *tabaco chuncho,* to replace coca (Schunke, pers. comm.).

In the upper Amazon, several species are employed as substitutes for coca powder, including three apocynaceous trees, *Couma macrocarpa* Barb. Rodr. and two species of *Lacmellea,* and at least two wild species of *Erythroxylum, E. macrophyllum* Cav. and *E. fimbriatum* Peyr., both of which are recognized by natives as wild cocas (Plowman, 1981). Whether these or other coca substitutes act merely as placebo quids or have some other as yet undiscovered active constituents remains unknown. Both coca substitutes and admixtures merit intensified ethnobotanical and phytochemical study while it is still possible to investigate their use *in situ*.

CHAMAIRO: AN OVERLOOKED ADMIXTURE TO COCA

I first learned about *chamairo* in 1976 from the Peruvian plant collector José Schunke Vigo who was employed as my expedition assistant in the Huallaga valley of eastern Peru. Schunke had first encountered *chamairo* during previous botanical collecting work in the Chanchamayo valley, where he observed that the Campa Indians added *chamairo* bark to their coca. At that time, Schunke was able to identify *chamairo* as a liana of the Bignoniaceae, but he did not know the genus nor had he collected specimens for study.

After consulting several general works on Peruvian botany, I was unable to find any mention of *chamairo.* Later the same year, I again met with the plant while consulting collections of coca paraphernalia at the Ethnografiska Museum in Göteborg, Sweden. I found a piece of unidentified liana labeled *yarnayru* which had been collected by Nordenskjöld in 1922 among the Campa on the Río Azotiqui (affluent of Río Perené) in Peru (specimen no. 21.10.142). Nordenskjöld noted simply that *yarnayru* bark was chewed with coca. *Yarnayru* is almost certainly identical with *chamairo,* but I was not able to study further the Göteborg specimen nor to attempt a botanical identification based on the wood anatomy.

Returning to Peru for field work in 1978, I discovered *chamairo* bark for sale by herb dealers in markets in Lima (La Parada) and in the central market of Tingo Maria. This strongly suggests that the plant is used by the general populace and is still widely available. The material was sold as long strips of bark, sometimes doubled over, sometimes coiled and tied in small bundles. It was very fibrous and tough in texture and reddish or greyish brown in color. It had a bitter and astringent taste. In both markets, *chamairo* was being sold as an admixture to coca and was said to originate in the Chanchamayo region (Dept. Junín).

In 1979, Dr. John Elick, an anthropologist working on Campa ethnomedicine, provided additional data on the use of *chamairo.* Elick observed the use of *chamairo* among the Campa of Peru on the Pichis, Nazaratequi and Neguachi rivers. While most of the Campa coca users preferred lime as a "sweetener" to

coca, there were several who seemed to like *chamairo* (Elick, pers. comm.).

HISTORICAL RECORDS OF CHAMAIRO

While researching the literature on coca and its uses, two early references to *chamairo* were discovered. The historical record of *chamairo* dates from the year 1790, when the Franciscan missionary Agustín Sobreviela encountered the plant during his travels on the Río Apurímac in Peru. He wrote of meeting two Indians who were traveling downstream to collect *chamairo,* a "tree bark" which they said they chewed along with coca (Izaguirre, 1923: 325).

The second report appeared about 100 years later. Olivier Ordinaire, a French explorer who traveled among the Campas of eastern Peru, described the following encounter (Ordinaire, 1892: 131):

"Seeing my breathlessness and exhaustion, the Campa chief pressed me to chew with my coca a dry bark which he gave me. I did what he said and almost immediately felt a real sensation of well-being and tranquility. The Campas make use of this bark, which comes from a liana called *chumayro,* whenever they have to fight against fatigue. They always have a provision of it in the bag which they carry on their shoulder. When they have run a long distance or made violent exercise, as in the tapir hunt, or when they are caught in a thunderstorm, they do not fail to chew a certain quantity of this bark mixed with coca leaves which they also consume in quantity. But all those whom I was able to ask told me that they can do without coca more easily than without *chumayro*....

"The liana which bears this name and which the same [chief] Puchana showed me later in the forest, grows in the thick jungles where it attains the thickness of a man's arm. The Indians cut it when it becomes as thick as a finger. They immediately strip the bark, the only part which they use, divide it into pieces about a foot long, dry it and store it in small bundles. To consume the bark, it only remains to remove, with a knife or a finger nail, the rugosities of a calcareous appearance which more or less cover it."

A portion of Ordinaire's description also appeared in Valdizán and Maldonado's treatise on Peruvian popular medicine (Valdizán & Maldonado, 1922).

Chamairo is known also in Bolivia. The most complete data were supplied by the Bolivian botanist Martín Cárdenas who studied the plant and its use during the Mulford Biological Expedition in 1921. Cárdenas (1969: 396) reported that the plant grows in the region of the Río Enadere near Ixiamas, in the Province of Iturralde in northern La Paz Department. In Rurrenabaque, the dry bark of *chamairo* is sold in coiled strips and, as in Peru, is closely associated with coca chewing. After a portion of coca is lightly chewed, a small piece of *chamairo* is added and finally formed together into a quid, to which is added a pinch of plant ash which is carried in a cow's horn. The effect of the mixture was said to resemble sweetened coca.

Cárdenas attempted to explain the derivation of the word "chamairo", which he believed to be Quechua in origin. The prefix "chama", according to Cárdenas, means "delight" and "iru" is a kind of forage grass which is used to make a wick or torch for lighting fires. He thus interpreted "chamairo" to mean "wick of delight", in reference to the pleasant effects produced upon chewing the vine.

Another Bolivian, Oblitas Poblete (1969), provided additional information on the use of *chamairo* as a medicinal plant:

"*Chamairo* is a liana which is found in the region of the Beni. When chewing coca, it serves to sweeten the leaf and make it more digestive. When drunk as an infusion, *chamairo* eliminates fatigue from the body. It is known as a stomachic and tonic and is much employed for colic and flatulence. The ash is used to dust wounds which then heal easily. Coca leaf chewed with *chamairo* is applied in a cataplasm to wounds, bruises, blows and sprains."

IDENTIFICATION OF CHAMAIRO

Cárdenas was the first botanist to identify the genus and family of *chamairo* as *Mussatia* in the Bignoniaceae, although he did not recognize the species. He also apparently collected an herbarium specimen in the Province of Caupulican in La Paz

Department with which he illustrated his brief account of *chamairo* (Cárdenas, 1969). However, no duplicates of this collection have been located among the Mulford Expedition collections at the New York Botanical Garden (Schofield, 1980, pers. comm.), at other major U.S. herbaria, nor in Cardenas' personal herbarium which is now preserved at the Instituto Miguel Lillo, Tucumán, Argentina.

In 1964, Dr. Gerald Weiss, an anthropologist at Florida Atlantic University, collected an ethnobotanical voucher specimen of *chamairo* among the Campa Indians of the Río Tambo in eastern Peru. Consisting of leaves and a piece of stem and preserved at the Field Museum, this specimen has been positively identified as *Mussatia hyacinthina* (Standl.) Sandw. by Dr. Alwyn Gentry, a specialist in American Bignoniaceae. A second authenticating specimen was collected by Gentry, Schunke and Aronson in the Huallaga valley of Peru near Tocache. This collection was recognized in the field as *chamairo* by Schunke and botanically identified by Gentry as *M. hyacinthina.*

The genus *Mussatia* includes only two species: *M. hyacinthina* which ranges from Mexico south to Guyana and Bolivia; and *M. Prieurei* (DC.) Bur. ex K. Schum., which occurs in the Guianas and Amazonian Brazil. To my knowledge, there have been no previous reports of economic uses for either species, and, according to Gentry (pers. comm.), the chemistry of *Mussatia* is completely unknown.

From the data presented here, it is clear that *chamairo* is rather widely employed as a coca admixture from central Peru south to northern Bolivia. It is employed mainly as a flavoring to sweeten coca but may also be chewed alone for its euphoric and medicinal effects. In view of these properties, *chamairo* bark should be examined for potential pharmacologically active constituents.

ACKNOWLEDGMENTS

I would like to thank José Schunke Vigo for providing valuable ethnobotanical information on *chamairo;* Dr. Alwyn Gentry for identifying specimens and providing other data;

Eileen Schofield for searching for specimens at the New York Botanical Garden; and Dr. Kjell Zetterström for permitting me to study specimens at the Ethnografiska Museum, Göteborg. I am also grateful to Dr. John Elick for sharing his field notes on *chamairo* and to Dr. Gerald Weiss for supplying the voucher specimen to the Field Museum. Part of the research reported in this paper was conducted at the Botanical Museum of Harvard University under a contract with the United States Department of Agriculture (No. 12-14-1001-230, R. E. Schultes, Principal Investigator).

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PLATE 5.

Plate 5. Chamairo bark as sold in market in Tingo María, Huánuco, Peru (*Plowman 7608*).

PLATE 6.

Plate 6. *Mussatia hyacinthina*. A, inflorescence. B, leaves. C, fruit. From Flora of Panama. Used by permission of the Missouri Botanical Garden.

BOTANICAL MUSEUM LEAFLETS
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WALLACE, SPRUCE AND *PALM TREES OF THE AMAZON:* AN HISTORICAL PERSPECTIVE.

MICHAEL J. BALICK

Alfred Russel Wallace's *Palm Trees of the Amazon and Their Uses* ensures the author an important place among students of the Amazonian palm flora and in economic botany. This book, consisting of line drawings of palm trees, botanical descriptions and ethnobotanical observations, was published in 1853. For the most part, it received good reviews, such as the anonymous one in the *Annals and Magazine of Natural History:* "...a valuable companion to the great work on palms by Martius [*Historia Naturalis Palmarum*]" (McKinney, 1971). Wallace's book remains a useful reference for students of the Amazonian palm flora and has recently been made more widely available by Coronado Press through a facsimile edition.

Wallace spent four years in the forests of South America. It was in this period that he compiled his account of the Palmae. During his return voyage to England, his ship, the brig Helen, caught fire and sank on August 6, 1852. Wallace saved the manuscript and drawings for what would become *Palm Trees of the Amazon and Their Uses* along with his drawings of fishes by putting them in a small tin. As a consequence of this fire, his specimens of palms were lost (George, 1964).

During his travels in South America, Wallace met Richard Spruce, the noted British botanist who spent 15 years (1849– 1864) studying and collecting the flora of the Amazon Valley and the northern Andes. Spruce's interests in the palms were similar to those of Wallace: in describing species, in understanding and recording geographic distributions and in compiling the local Indian uses. Spruce's explorations and studies are discussed in papers by Angel (1978) and by Schultes (1953, 1968, 1978a and 1978b) and in *Notes of a Botanist on the Amazon and Andes* (Spruce, 1908), a work edited by Wallace and excerpted from Spruce's own letters and journals.

By all accounts, these two explorer-biologists appear to have had a great regard for each other. In the introduction to his posthumous edition of Spruce's notes and letters, Wallace (Spruce, 1908) offered the following tribute: "... and I have myself so high an opinion of my friend's [Spruce's] work, both literary and scientific, that I venture to think the present volumes will take their place among the most interesting and instructive books of travel of the nineteenth century."

In a commentary of Wallace's *Palm Trees of the Amazon and Their Uses,* Spruce (1871) wrote "... a handy volume, which contains the most characteristic representation of Amazonian palms that exist within a small compass."

During a recent visit to the Royal Botanic Gardens, Kew, I had the privilege of studying some of Spruce's correspondence and notes relating to palms and their utilization, notes now preserved in the library archives at that institution. His precise accounts of aboriginal uses, many of which are still current among the inhabitants of Amazonia over a century later, are well worthy of study.

Reading a letter to Sir William Hooker, written by Spruce in 1855, I noticed a postscript paragraph in reply to Hooker's query on *Palm Trees of the Amazon and Their Uses.* This section is reproduced in its entirety as follows:

> "You asked me about Wallace's Palms. When he came down the Rio Negro in Sept. 1851 he showed me a few figures of palms. I pointed out to him which seemed to be new, and encouraged him to go on; I also proposed that we should work them up together, I taking the literary part and he the pictorial, which he declined. As I had also met with some of his palms and had my names for them, this caused me to relax in my study of the tribe, seeing myself likely to be forestalled in the results of my labors. —He has sent me a copy—the figures are very pretty, and with some of them he has been very successful. I may instance the figs of Raphia taedigera and Acrocomia sclerocarpa. The worst figure in the book is that of Iriartea ventricosa. The most striking fault of nearly all the figs of the larger species is that the stem is much too thick compared with the length of the fronds, and that the latter has only half as many pinnae as they ought to have. —The descriptions are worse than nothing, in many cases not mentioning a single circumstance that a botanist would most desire to know; but the accounts of the uses are good. —His *Leopoldinia Piassaba* and *Mauritia Carana* are two magnificent new palms,

> both correctly referred to their genus; but the former has been figured from a stunted specimen. I have got a series of specimens for your museum, showing the way in which the Piassaba grows on the tree."

Upon study, this letter (the original of which is reproduced in Fig. 1) reveals in clearer outline the professional relationship between Spruce and Wallace and their mutual but competitive interests in the Palmae: their meeting in the Amazon, the discovery that they had made similar collections in this important family, Spruce's offer to collaborate on the book and Wallace's subsequent refusal. It appears that Spruce was discouraged on learning that Wallace had discovered and intended to name and describe the same palms, primarily those along the Rio Negro, that he had studied. He writes of "relaxing" his study of the palms, in view of the fact that Wallace would return to England and publish his results before Spruce left South America. Clearly, in this instance, Spruce felt botanically somewhat overshadowed by Wallace, whom he considered a distinguished zoologist and friend.

From the letter, it is apparent that Spruce was dissatisfied with Wallace's book. He is specifically critical of the proportional aspects of the plates (see Fig. 2) and comments that Wallace's descriptions (which Spruce had offered to write) "... are worse than nothing, in many cases not mentioning a single circumstance that a botanist would most desire to know...."

Wallace's shortcomings apparently prompted Spruce to publish a more botanically oriented work on the palms of the Amazon which he entitled *Palmae Amazonicae sive Enumeratio Palmarum in Itinere suo per Regiones Americae Aequatoriales Lectarum* (Spruce, 1871). This work, less generally known than that of Wallace, contains comprehensive discussions of palm genera, Latin descriptions of the species, and comments on many of those which he had studied during his prolonged field work in South America.

This previously unpublished document sheds new light on Spruce's seemingly competitive relationship with Wallace in regard to the palms. Perhaps Spruce's judgement of Wallace's work might be thought to be too harsh when one considers the

loss of Wallace's herbarium. Spruce was evidently disappointed by Wallace's rejection of his offer of collaboration and by the publication of what he considered an inferior book. His candid and confidential remarks to Sir William Hooker offer a revealing picture of one aspect of his relationship with Wallace.

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I am grateful to Dr. John Dransfield (Herbarium) and Miss Smith (Archivist) for their valuable assistance and their interest shown during my stay, to Andrew and Ruth Henderson for their gracious hospitality, and to the Director, Royal Botanic Gardens, Kew, for permission to publish the photograph of Spruce's letter. Doctors Ghillean T. Prance, Richard Evans Schultes and Rupert Barneby have offered valuable comments on the manuscript, and Anne Schwartz provided assistance with the illustrations.

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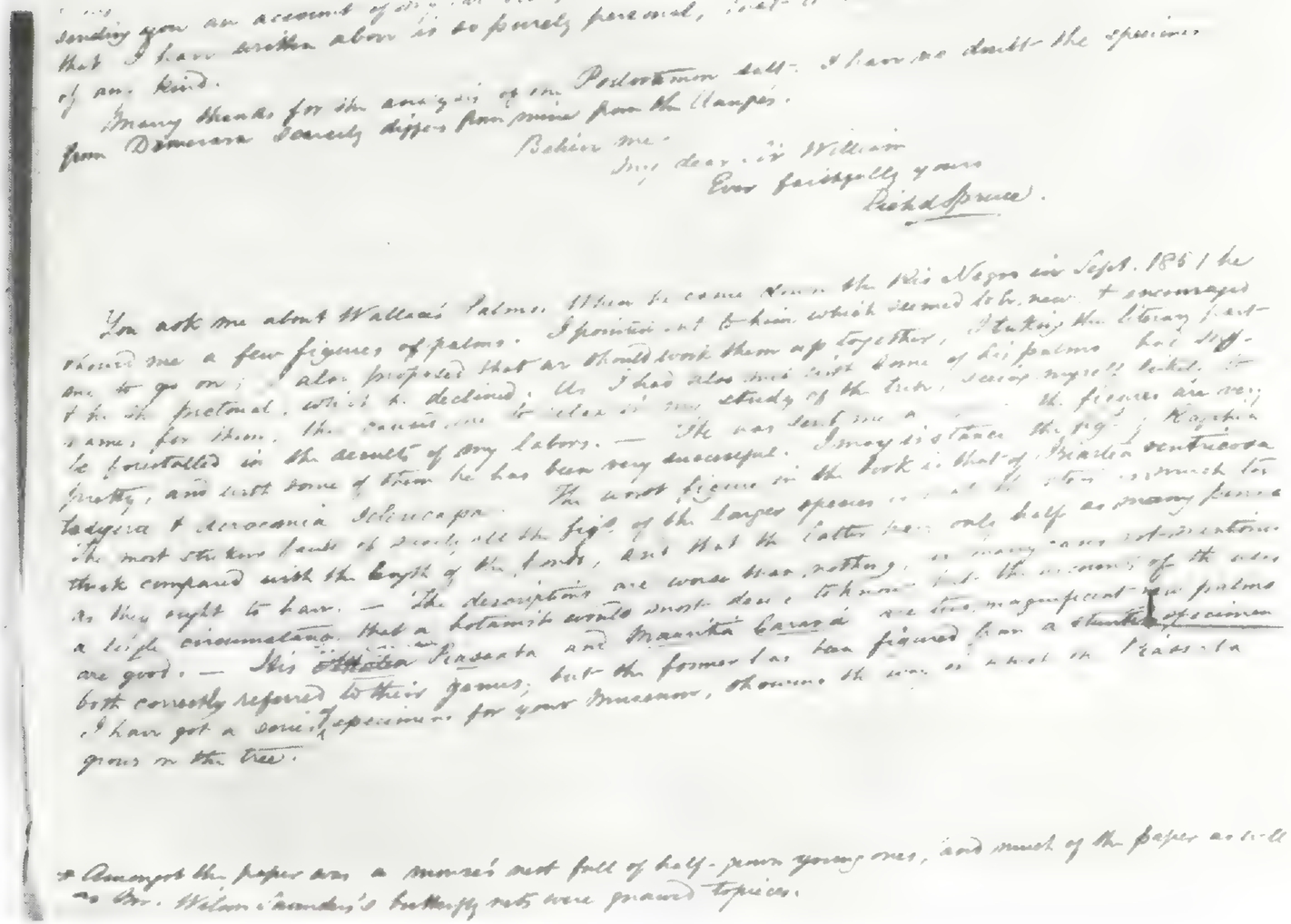

Plate 7. A portion of Spruce's letter to Hooker, from the Archives of the Royal Botanic Gardens, Kew. Reproduced by courtesy of the Director.

Plate 8. Wallace's drawing of *Oenocarpus bacaba* compared with a photograph of the same on the Colombian Amazon. The disparity in scale between leaves and trunk and the too small number of pinnae per leaf shown in the drawing are just as mentioned in Spruce's letter. Photograph from the Botanical Museum of Harvard University; drawing courtesy of The New York Botanical Garden.

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DE PLANTIS TOXICARIIS E MUNDO NOVO TROPICALE COMMENTATIONES XXIX.

A SUSPECTED NEW AMAZONIAN HALLUCINOGEN

RICHARD EVANS SCHULTES

I

During my ethnobotanical studies in the northwestern Amazon of Colombia, I gathered ethnopharmacological data on many plants employed by the numerous tribes of the area. It was not always possible to investigate thoroughly certain reports—especially an occasional report of a medicine man or practitioner of curing through the use of mind-altering agents.

In previous publications, I have indicated that further work of an ethnobotanical nature in the northwest Amazon is urgently needed before acculturation obliterates much of the local and traditional folk lore and the practices of medicine men. I have also stated my belief that there are minor hallucinogenic plants left to identify and study which are still in use in the remote fastnesses of this jungle area.

One such problem, for example, concerns the identification of a forest liana with a milky latex—probably a member of the Apocynaceae—utilized in Amazonian Colombia in special ceremonies as a kind of caapi which is the name of the widely used hallucinogenic drink prepared from *Banisteriopsis Caapi.* (Spr. ex Griseb.) Morton.

II

There are, however, other fascinating leads which the ethnobotanist must follow while there is yet time. These leads concern members of the rubiaceous genus Pagamea, especially the shrub *P. macrophylla* Spruce ex Bentham.

This plant, found growing in the white sand *caatinga* vegetation which is very common in the basin of the Ríos Apaporis and Vaupés and their tributaries, is esteemed by medicine men

of the Barasana and Makuna tribes of the Río Piraparaná of Colombia. I did not witness its use during my field research amongst these Indians, but I did obtain what may be valuable reports concerning the plant.

The Barasana are heavily habituated to the use of coca. Aged men of this tribe frequently suffer from stomach or intestinal bleeding, a condition which, although it might have sundry causes, they attribute—and probably quite correctly—to the long and excessive use of coca powder. In an effort to alleviate this trouble, they recommend a hot tea of the leaves and bark of *Pagamea macrophylla,* which they call *ma-nu-su-ka-ta (Schultes et Cabrera 17581).* This use represents a popular and probably frequent medicinal application of the plant. The nomadic Makús of the Río Piraparaná, who know this species as *ma-na-shu-ke-ma,* recognize that the plant has toxic properties but do not use it.

There is, however, another—and perhaps much more important—use of *Pagamea macrophylla.* The leaves are pulverized and aspirated in the form of a snuff by medicine men during ceremonies of divination. Does this plant product have hallucinogenic properties? Does it merely tranquilize the medicine man? Is it a stimulant? Or is it simply a ceremonially significant use with no biochemical basis?

Pagamea macrophylla *Spruce ex Bentham* in Journ. Linn. Soc. 1 (1857) 110.

Tree, usually 10–20 feet tall. Branches thick. Leaves subcoriaceous, ovate to oblong-elliptic, short-acuminate, mostly 16–22 cm. long. Stipules membranaceous, acuminate, up to 3.5 cm. long, deciduous. Panicle thrysoid, trichotomous, densely flowered. Flowers rather large, sessile: calyx cupuliform, up to 4 mm. long; corolla greenish, 4-fid, lobes densely villose within; anthers linear, stipitate; style filiform, semi-2-fid.

COLOMBIA: Comisaría del Vaupés Río Piraparaná Caño Paca, "Small treelet." September 19, 1952 *Richard Evans Schultes et Isidora Cabrera 17581.*

The only genus of the Rubiaceae known to be hallucinogenically used in Psychotria, the leaves of several species of which contain tryptamines and are used as additives to the narcotic drink caapi or ayahuasca. This ethnobotanical reference

—that Barasana medicine men snuff *Pagamea macrophylla* in ceremonies—is certainly not proof that the plant has hallucinogenic properties. It is, however, sufficient indication that a member of this alkaloid-rich family may represent an hitherto undected psychoactive agent and to warrant phytochemical study of the species.

III

Pagamea is a genus of rubiaceous trees and shrubs with 20 to 23 species of tropical northern South America. It has been suggested that Pagamea belongs more properly in the Loganiaceae (Standley in Field Mus. Nat. Hist. Bot. 13 (1936) 144). It was described in 1775 by Aublet from French Guiana. The leaves are opposite, with deciduous stipules connate in a kind of sheath. The axillary or terminal inflorescences are borne in the form of small heads, spikes, racemes or panicles. The hermaphroditic flowers are usually 4- to 5-merous. The dentate or lobate calyx, sometimes truncated, is persistent. The corolla lobes in bud are valvate. The stamens number four to five. The ovary is superior, 2- to 5-locular, with one ovule per locule. The fruit is a drupe.

In Venezuela, the species of Pagamea are known as *ajo de paloma* ("garlic of the dove"). For Colombia and Brazil, no common names of Pagamea are reported in Spanish or Portuguese.

Species of this genus are restricted to the northwestern part of the Amazon, the adjacent areas of the upper Orinoco and the Guianas. They appear to be in general associated with the Venezuelan-Guianan land mass. In the Colombian Amazonia, they occur on the flat quartzitic mountains of Cretaceous age in the Vaupés and Apaporis River basins or with the sandy remnants of these eroded mountains.

IV

The Kubeo Indians living on affluents of the Río Vaupés in Colombia have an interesting use for *Pagamea coriacea* Spruce ex Bentham, a species related closely to *P. macrophylla.* They heat the blue-black fruits in oil from the palm *Jessenia Bataua*

(Mart.) Burret to prepare a medicine which is dropped into the ears for what appears to be a fungal infection of the ear-drum (*Schultes et Cabrera 19169:* Río Karurú, Mesa de Yambí, Savannah Goo-ran-hoo-dá, Comisaría del Vaupés: *Schultes 22611:* Río Kuduyarí, Savannah Yapobodá, Comisaría del Vaupés.

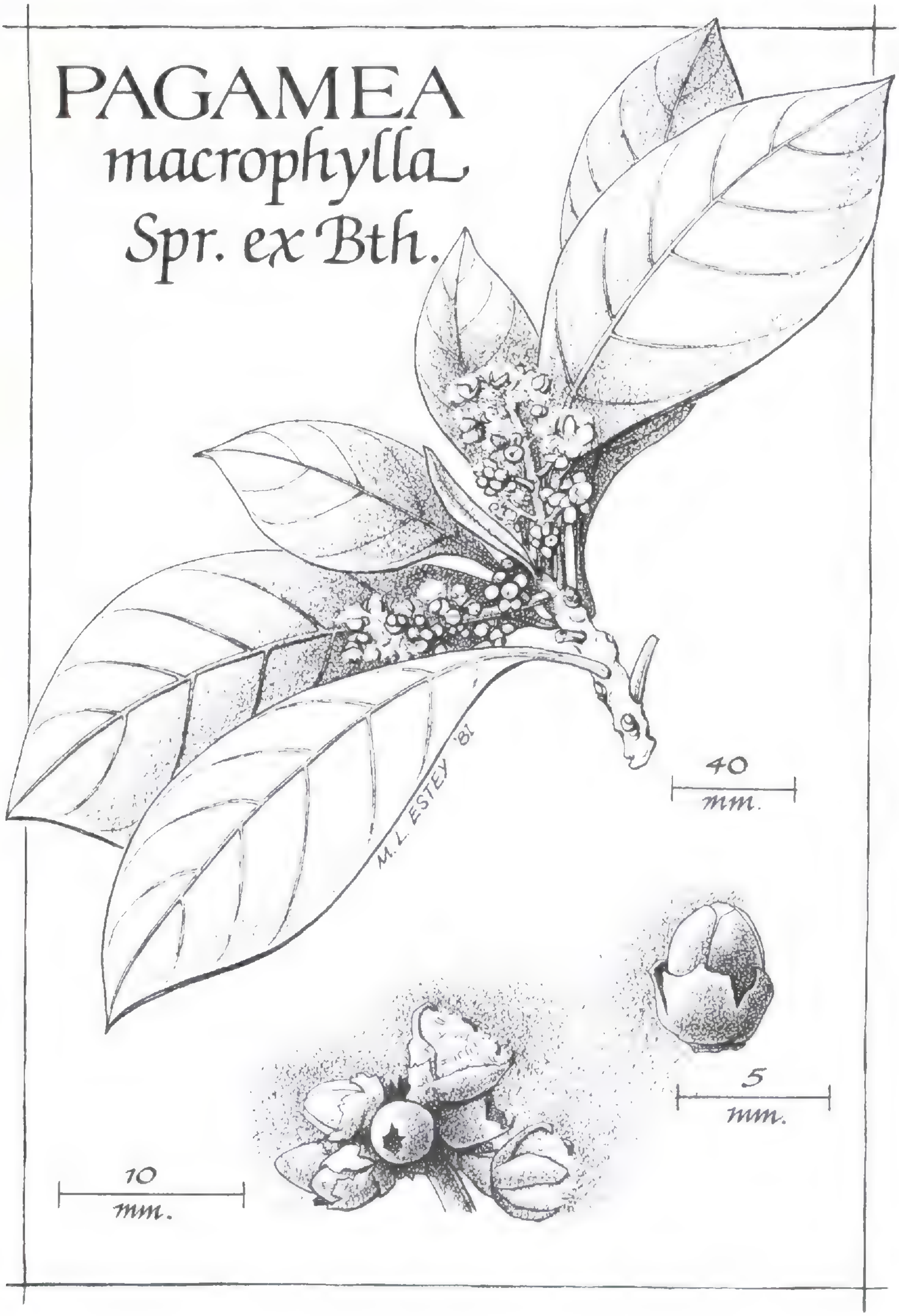
The Taiwanos of the region of the Raudal de Jirijirimo on the Río Apaporis in Amazonian Colombia value the plant as an efficaceous remedy for reestablishment of the ability to walk following attacks which, in age, appear to deprive Indians of the free use of the legs. The cause of this curious but not uncommon condition is not known. The bark of the young branches is scraped and, in fresh condition, is boiled into a decoction which must be drunk over a period of two or three weeks. Administration of this tea is reported to result in strong stimulation of the afflicted patient and frequently in his ability to regain muscular use of the legs (*Schultes et Cabrera 12467, 14933, 14953:* Río Apaporis, Raudal de Jirijirimo, Comisaría del Vaupés).

V

In view of these several interesting ethnopharmacological reports, a phytochemical study of the genus Pagamea would appear to be fully warrented.

Little is known of the chemistry of Pagamea. Da Rocha et al. (in Inst. Nac. Pesquisas Amaz. Química, no. 12 (1968) 42) reported that the stems and leaves of *P. coriacea* are alkaloid-negative, yet a spot-test which I made on fresh leaves with Dragendorff reagent was positive (*Schultes et Cabera 19921*).

PLATE 9.



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A GENERIC REVISION OF THE SPIRANTHINAE

LESLIE A. GARAY

DEDICATED
TO THE MEMORY OF

GUIDO FREDERICO JOÃO PABST
1914 – 1980

FRIEND AND COLLEAGUE, FORMER RESEARCH FELLOW IN ORCHIDOLOGY IN THE BOTANICAL MUSEUM, HARVARD UNIVERSITY AND FOUNDER-DIRECTOR OF HERBARIUM BRADEANUM, RIO DE JANEIRO, WHO WAS ASSOCIATED WITH THE EARLY PHASE OF THE INVESTIGATIONS OF THE SPIRANTHINAE COMPLEX.

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INTRODUCTION

The last review of the Spiranthinae at the generic level was published by Schlechter in 1920 (Beih. Bot. Centralbl. 37, pt. 2: 317 454). At that time Schlechter gave an extensive historical background of the development of the various generic boundaries, including those which he himself set up as new. Consequently these details are not repeated here. Schlechter summarized his findings in a key accounting for 24 genera which he grouped on the basis of the structure of the rostellum and viscidium into four separate alliances. His new treatment, at first, was well received, but the enthusiasm it generated soon started to wither, especially along the American frontier, as the assignment of the various species underwent scrutinous evaluations. Perhaps the most convincing effort to discredit Schlecter's work was published by Ames in 1922 (Orchid.7: 127 129) where he argued a seemingly contradicting evidence found in *Spiranthes novaezelandiae*. The flowers in this latter species do not exhibit a well-defined rostellum, yet Schlechter included it in the genus Spiranthes, which is characterized, among others, by a bifid or bidentate, sharp-pointed rostellum. Of course, in 1922, the taxonomists were not used to thinking in terms of autogamous populations of which *S. novaezelandiae* is a clear-cut representative. As a matter of fact, autogamy is a very common phenomenon in the entire Spiranthes-related complex. The recently described *S. hongkongensis* is another typical example.

Admittedly I was also supporting Ames' approach, until I had a chance to investigate the whole complex on my own. What truly disturbed me, however, was the fact that Schlechter did not account for a number of described species, including some of his own, on the one hand, while on the other hand due to erroneous observations he assigned a number of species to the wrong genera. One of these species was *Spiranthes obliqua* J. J. Sm. from Java. It was discovered in the Bogor Botanical Garden associated with Carludovica sp. J. J. Smith published excellent drawings of the floral details, all of which clearly have shown that this particular binomial is not referable to the genus Spiranthes in the strict sense. Until recently nothing more was

known about that species. In 1976, it was described as *Manniella hongkongensis* and again in 1978 as *Pelexia Hameri.* Since that time I have seen additional material from Ceylon and from Guadeloupe in the West Indies. In all instances the plants were gathered in Botanical Gardens. Obviously a Pelexia from Java was too much for Schlechter in 1920!

Stenorrhynchus cinnabarinus, a common Mexican plant, is another case based on wrong observations. The genus Stenorrhynchos (correct spelling) was always characterized among others by the rigid, sharp-pointed rostellum. Yet, *S. cinnabarinus* has a soft, pliable, linear-oblong, blunt rostellum. Today this particular character, together with other associated criteria, as will be shown later, marks *S. cinnabarinus* as being amply distinct from Stenorrhynchos.

In 1920, when Schlechter published his revision, he accounted for 280 species in 24 genera. Of these genera 16 were new and 7 monotypic. The revision here accounts for 390 species in 44 genera. Of these genera 14 are new and 13 monotypic.

It has been said many times that a genus is not good, unless one can separate it from other genera through satisfactory key characters. At the beginning I did attempt to expand the key published by Schlechter, but after a third attempt I had to abandon the idea. The key to the genera published here is based on an entirely new approach which underwent no less than nine revisions. The structure of the rostellum is, of course, still a very important character, but no longer is used here to separate groups of genera. Perhaps one of the most unique divisional characters, which until now was totally overlooked, is the "terminal" versus "anterior" stigmata. Incidentally, both types of stigmata were included formerly in the genus Stenorrhynchos. The fusion of the dorsal sepal with the lateral sepals to form a sepaline tube or nectary is another important character; so are the presence or absence of a distinct column-foot and the pliable or rigid texture of the rostellum.

In line with the requirements of the International Code of Botanical Nomenclature, every generic name, whether accepted or in synonymy, has been typified either for the first time or the previous typifications are cited. This method, as it were,

automatically sets the limits of the diversity which logistically can be expected to occur within a genus.

When Schlechter described the limits of his subtribe Spiranthinae, he characterized the group as having fasciculate roots, basal leaves, vaginate scape and resupinate flowers. It is true that most of the species fall within this broad outline. A decumbent or a short rhizome is present, however, in the genera Helonoma and Hapalorchis, as well as in a number of species of the genera Pelexia and Sarcoglottis. Non-resupinate flowers are known to occur randomly in the genera Beadlea, Hapalorchis, Pseudocranichis and Nothostele.

This last mentioned generic name stands for an unusual and rare plant from Brazil. The column is represented by an incomplete fusion of the filament of the stamen and the style with the terminal, confluent stigmata. The pollinia with distinct caudicles are attached to a small, round viscidium.

Among the genera with terminal stigmata, Sacoila must be singled out. This genus originally was established by Rafinesque in 1837, as one of his many routine segregates of the then all-encompassing Neottia. It is noteworthy that not even Schlechter noticed the remarkable structural differences between the plants of Sacoila and Stenorrhynchos. In the former genus the flowers have terminal stigmata, long, decurrent column-foot with free tips and the lateral sepals are spur-like; in the latter genus the flowers, however, are noted for their anterior stigmata, for the oblique base of the column is without a distinct foot, and the lateral sepals are never spur-like.

For a long time I was aware of the bizarre structure of the flowers which were described as *Cranichis thysanochila*. It has been assigned to Cranichis most probably because of the non-resupinate flowers. The resemblance, however, ends here. The peculiar tear-drop-like column has a substipitate, oblique base rapidly expanding upwards, truncate at the top. The two stigmata are separate, saddle-shaped on the sides of the truncate rostellum. In that particular aspect, the column is reminiscent of the genus Altensteinia. The rest of the floral structures as well as the entire plant is clearly that of the Spiranthinae. Hence, I propose the name Pseudocranichis. Plants of this unusual genus

were already known to Reichenbach, who also regarded them as a representative of a new genus.

I consider the position of the genus Manniella to be among the Spiranthinae. Reichenbach's original statement that the column has two auricles at the apex is based on a wrong observation. The clinandrium, *i.e.*, the anther bed, in Maniella consists of a square, basket-like structure with the erect sides free from one another and from the sides of the stigmatic cavity; the bottom of the clinandrium is flat, not infundibuliform as in the rest of the Spiranthinae. Apart from this unique feature, Maniella agrees with the remainder of the Spiranthinae.

When I described *Manniella americana* in 1962, I did it on account of the great similarity in the structure of the sepaline tube found in this species and in *M. Gustavi,* the type of the genus from West Africa. Since that time I have received good material of both species which has enabled me to clarify the status of *M. americana.* The plants are native to the Guyana Highlands, and commonly autogamous. They have a short, decumbent rhizome, and an infundibuliform clinandrium. *Spiranthes bifida,* also having the same distribution, appears to be congeneric. These two species together comprise now the genus Helonoma. Incidentally *Spiranthes bifida* is based on specimens with true peloric flowers in addition to its being autogamous.

Because of the manner in which Schlechter circumscribed his genus Deiregyne, it must be typified by *D. chloreaeformis.* The other species included in it by him are now transferred either to Aulosepalum or to Gularia. Pamela Balogh's contention that they are all referable to Schiedeella (Orquidea, Mex. 8: 37–40, 1981), presumably because they all have translucent, chartaceous sheaths covering the scapes, suggests her strong preference for gross appearances over diagnostic floral details. Deiregyne at a future time may be divided into two genera on account of the nature of the rostellum. The group containing the type of the genus has a blunt rostellum with revolute sides; the other group is characterized by an acuminate rostellum without revolute sides.

Since Stenorrhynchos is typified by the widespread *S. speciosum,* a number of south Brazilian elements no longer can be

retained in the genus. For those plants with a dense, sceptre-like inflorescence, more or less sigmoid lip and laterally toothed rostellum the name Skeptrostachys is proposed here.

Monotypic genera are always frowned upon by botanists, and are often regarded as by-products of extreme splittings. Personally I look upon them in the orchids as inevitable, peripheral products of anagenesis, *i.e.*, the evolutionary refinements within a main phylogenetic branch of the family, in this case, the Neottioideae. Dressler recently elevated the whole Spiranthes complex to a separate subfamily, Spiranthoideae (Selbyana 5: 197–206, Dec. 1979). His new system of classification—so aptly summed up by Schultes in his review in The American Orchid Society Bulletin—is remarkable, among others, in combining heterogeneous, diverse elements into NEW SUBFAMILIES, often with old names, such as Neottia and Orchis into Orchidoideae, to mention but one. Dressler summarized his new system in a diagrammatic presentation (p. 203, fig. 3), which, indeed, is reminescent of a supernova, where the fragments of the original components are thrown out and randomly combined to give birth to a NEW CREATION.

ACKNOWLEDGMENTS

With sincere thanks and appreciation I wish to acknowledge the patient kindness of my friends and colleagues in the Ames Orchid Herbarium, Herman R. Sweet and Walter Kittredge, for their ever helpful criticisms as I burdened them step by step throughout the preparation of this study. Admittedly the time and effort spent on the preparation of this generic revision is hardly apparent from a casual perusal of these pages.

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DESCRIPTIONS OF NEW SPECIES

Deiregyne confusa Garay, sp. nov.

Plantae terrestres, elatae, usque ad 50 cm. altae; radicibus fasciculatis, tuberosis, breviter stipitatis, pubescentibus, crassis; foliis sub anthesin vulgo absentibus, anguste lanceolatis, acutis vel subacuminatis, basi cuneatis, subsessilibus vulgo plurimis, usque ad 20 cm. longis, 2 cm. latis, scapo erecto, valido, plurivaginato; vaginis lanceolatis, acuminatis, remotis, sursum descrescentibus et in bracteas abeuntibus; inflorescentia secunda vel subsecunda, laxe pluriflora; bracteis ovato-lanceolatis, longe acuminatis, ovariis vulgo superantibus, usque ad 2 cm. longis; floribus satis magnis, pubescentibus; sepalo postico lanceolato-oblongo, acuto, valde cucullato, apice reflexo, extus glanduloso vel glanduloso-pubescenti, usque ad 14 mm. longo, 4 mm. lato; sepalis lateralibus porrectis, lineari-oblongis, acutis, extus glanduloso-pubescentibus, usque ad 14 mm. longis, 2.5 mm. latis; petalis sigmoideo-linearibus, acutis, glabris, usque ad 14 mm. longis, 2.5 mm. latis; labello e conduplicato-excavato basi pandurato, in medio valde constricto, parte apicali plano, carnoso, ovato, acuto vel subrotundo, margine subcrenulato, parte mediano subrotundo, conduplicato-cochleato, parte basali margine calloso incrassato, pubescenti, in medio excavationis callo lineari, longitudinali, pubescenti ornato; toto labello usque ad 17 mm. longo, 8 mm. lato; columna generis; rostello anguste triangulari, subacuminato; ovario cylindrico, leviter torto, subcylindrico, pubescenti.

Mexico: Hildalgo, Lagoon of Metztitlan, 1600 m. alt. Coll. Juan Gonzales *s.n.*, sub Nagel 2194! Type! (AMES).

It differs from *D. durangensis* (A. & S.) Garay in having glandular-pubescent sepals, a differently proportioned lip with a different callus at its base and the shape of the rostellum. All specimens, with the exception of the holotype collection which I have seen named as "*Spiranthes durangensis*" including those from Texas, U.S.A., are all referable to this new species.

Deiregyne pandurata Garay, *sp. nov.*

Plantae terrestres, erectae, usque ad 40 cm. altae; radicibus fasciculatis, crassiusculis, breviter tomentosis; scapo stricto, supra basin 2-foliato, sursum bracteis hyalinis, decrescentibus transeunti; inflorescentia laxe pauciflora; bracteis ovato-lanceolatis, acuminatis, hyalinis, ovariis superantibus, usque ad 2 cm. longis; floribus satis magnis, glabris, niveis, nervis discoloribus; sepalo postico ligulato, acuto, usque ad 12 mm. longo, 2.5 mm. lato; sepalis lateralibus oblongo-linearibus, obtusis, usque ad 13 mm. longis, 2 mm. latis; petalis lineari-oblanceolatis, paululo sinuosis, basin versus angustatis, usque ad 10.5 mm. longis, 2 mm. latis; labello e cuneata basi anguste pandurato, parte basali angulato-rhombeo, parte apicali ovato, carnoso, leviter crenulato, margine supra basin utrinque caloso-incrassato, in medio isthmifero; toto labello usque ad 14 mm. longo, 5 mm. lato; columna gracili; 7 mm. longa; rostello oblongo-ligulato, acuto; ovario clavato, leviter torto.

Mexico: Durango, between Guanacevi and Guadalupe. Coll. Juan Gonzales no. 5810! Type! (AMES).

This specimen was included by Williams in the type description of his *Spiranthes falcata* L.O.Wms. It differs from the later in the shape and proportions of the petals and lip and the construction of the column, especially in the shape of the rostellum.

Deiregyne rhombilabia Garay, *sp. nov.*

Plantae terrestres, erectae, supra metrales; radicibus fasciculatis, carnosis, stipitato-tuberosis; foliis caulinis, satis tenuis, anguste ellipticis, acutis, basi longe vaginantibus imbricatisque, sub anthesin satis emarcidis, usque ad 15 cm. longis, 4 cm. latis; calibus erectis, validis, strictis, dimidio inferiore usque ad 5-foliatis, dimidio superiore vaginis, hyalinis imbricatisque omnino obtectis; spica terminali, spiraliter quaquaversa, dense multiflora, usque ad 25 cm. longa; bracteis hyalinis, lanceolatis, acuminatis, usque ad 25 mm. longis; floribus inter mediocres, griseo-viridibus; sepalo postico oblongo-ligulato, obtuso, extus pubescenti, usque ad 10 mm. longo, 4 mm. lato; sepalis

lateralibus obliquis, lineari-oblongis, obtusis, usque ad 11 mm. longis, 2.3 mm. latis; petalis e cuneata basi dolabriformibus, obtusis, usque ad 9 mm. longis, 2.8 mm. latis; labello carnoso, rhombeo, angulis rotundatis, antice obtuso, supra basin margine incrassato, pubescenti, usque ad 10 mm. longo, 5 mm. lato; columna cylindrica, 4 mm. longa; ovario ovoideo, pubescenti, sessili, torto, usque ad 5 mm. longo.

Mexico: Morelos, near Tlayacapan. Coll. Juan Gonzales 2163! Type! (AMES).

This new species is well represented in herbaria under the name of *Spiranthes Arseniana* Krzl. This confusion is due primarily to the material originally distributed under Arsenè, 6671, the type number of *S. Arseniana.* I have examined the holotype which is in Montpellier, and it represents *Pelexia Schaffneri* (Rchb.f.) Schltr. A duplicate of the holotype number however, in the United States National Herbarium, Washington, D.C., is a specimen identical with the present new species. Obviously the Washington material is responsible for the previous misapplication of the binomial, *Spiranthes Arseniana.*

Mesadenella angustisegmenta Garay, *sp. nov.*

Plantae terrestres, elatae, usque ad 30 cm. alta; radicibus fasciculatis, carnosis, pubescentibus; foliis basilaribus, plurimis, distincte petiolatis, petiolis canaliculatis, usque ad 6 cm. longis; lamina oblique ovato-elliptica, acuta vel subacuminata, usque ad 11 cm. longa, 5 cm. lata; scapo erecto, dimidio inferiori vaginato, dimidio superiori satis laxe spicato; bracteis lanceolatis, acuminatis, usque ad 15 mm. longis, sursum decrescentibus; floribus virescentibus, parvulis, extus pubescentibus; sepalo postico anguste ovato, acuto, usque ad 5 mm. longo, 1.2 mm. lato; sepalis lateralibus oblique lineari-oblongis, obtusis, usque ad 7 mm. longis, 1.5 mm. latis; petalis lineari-oblanceolatis, acutis, usque ad 4.5 mm. longis, 1 mm. latis; labello anguste pandurato, parte superiori elliptico, subcrenulato, carnosulo-tuberculato, parte inferiori sagittato, disco in medio pubescenti; toto labello usque ad 6 mm. longo, 2 mm. lato; columna gracili, facie pubescenti, usque ad 3 mm. longa, basi in pedem

aequilongam producta; ovario hirsuto, clavato, usque ad 8 mm. longo.

Venezuela: Edo. Zulia, in forests of Río Lora. Coll. Pittier 10985! Type! (AMES).

Mesadenella peruviana Garay, *sp. nov.*

Plantae terrestres, usque ad 35 cm. altae; radicibus carnosis, elongatis, pubescentibus; foliis basilaribus, plurimis, e cuneata basi obovato-oblanceolatis, acutis, usque ad 24 cm. longis, 5 cm. latis; scapo erecto, plurivaginato, supra laxe plurifloro; bracteis lanceolatis, acuminatis, usque ad 15 mm. longis; floribus parvulis, flavidobrunneis, extus pubescentibus; sepalo postico lanceolato-oblongo, acuto, usque ad 6 mm. longo, 1.8 mm. lato; sepalis lateralibus obliquis, arcuatim lineari-oblongis, obtusis, usque ad 8 mm. longis, 2 mm. latis; petalis obscure lineari-oblanceolatis, acutis, usque ad 5 mm. longis, 1 mm. latis; labello panduriformi, utrinque parte ovato-ellipticis, antice rotundatis, basin bicornutis, usque ad 7 mm. longis, 2 mm. latis; columna cylindrica, paululo arcuata, 2.5 mm. longa; ovario cylindrico, haud torto, dense piloso, usque ad 8 mm. longo.

Peru: Depto. Huanuco, Quebrada Las Pavas, 5 km. s. of Tingo Maria on road to Las Palmas, 720 m. above sea level. Coll. Plowman & Kennedy 5713! Type! (AMES).

Odontorhynchus alticola Garay, *sp. nov.*

Plantae terrestres, sub anthesin aphyllae, usque ad 30 cm. altae; radicibus fasciculatis, carnosis, pubescentibus; scapo erecto, pubescenti, dimidio inferiori vaginis bracteiformibus, acuminatis obtecti, dimidio superiori laxe spicato, multifloro; bracteis ovato-lanceolatis, longe acuminatis, ovariis superantibus, usque ad 15 mm. longis, sursum decrescentibus; floribus virescentibus, extus pubescentibus; sepalo postico ovato, concavo, obtuso, usque ad 8 mm. longo, 3.5 mm. lato; sepalis lateralibus obliquis, lineari-oblongis, obtusis, usque ad 9 mm. longis, 2 mm. latis; petalis lineari-subfalcatis, obtusis, usque ad 8 mm. longis, 1.2 mm. latis; labello sessili, basi cochleato, intus bicornuto, deinde in ambitu obovato, valde concavo, carnosulo,

apicem versus constricto, lobo terminali undulato, reflexo, membranaceo, apice ipse truncato, toto labello usque ad 8 mm. longo, 4 mm. lato; columna crassa, facie pubescenti, usque ad 3 mm. longa; ovario plus minusve clavato, puberulo, haud torto.

Peru: Depto. Puno, Prov. Carabaya, Machea, 2800 m. alt. Coll. Vargas 6965! Type! (AMES).

This new species is known also from Argentina, and is illustrated as *Brachystele chlorops* (Rchb.f.) Schltr. in Bol. Soc. Argentina Bot. 16(4): 356, 1975.

Odontorhynchus variabilis Garay, *sp. nov.*

Plantae terrestres, elatae, usque ad 40 cm. altae; radicibus fasciculatis, carnosis, pubescentibus; folius plerumque basalibus, paucis, lanceolatis vel lanceolato-ovatis, acutis, basi conduplicato-subpetiolatis, deinde vaginantibus, usque ad 12 cm. longis, 2.5 cm. latis, vulgo minoribus; caulibus strictis vel paululo arcuatis, multivaginatis, apice dense spicatis; bracteis lanceolatis, acuminatis, usque ad 2 cm. longis; floribus semiapertis, extus pubescentibus, vulgo viridis, interdum labello sucineo colorato; sepalo postico lineari-oblongo, obtuso, usque ad 9 mm. longo, 3 mm. lato; sepalis lateralibus obliquis, lineari-oblongis, obtusis, usque ad 9 mm. longis, 2 mm latis; petalis lineari-spathulatis, dimidio superiori subrhombeis, margine integris vel subcrenulatis, usque ad 9 mm. longis, 2 mm. latis; labello varie reflexo, basi excavato, sub spice constricto, 3-lobo, lobis lateralibus erectis, subparallelis, explanato late ellipticis, lobo intermedio subquadrato vel transverso, margine crenulato ad grosse eroso denticulato, disco incrassato, in medio callis subparallelis, pubescentibus donato, toto labello usque ad 7 mm. longo, 5 mm. lato; columna brevi, sursum leviter dilatata, usque ad 2.5 mm. longa; ovario clavato, apicem versus pubescenti, usque ad 8 mm. longo.

Chile: Prov. Chiloé, Cucao, ca. 50 m. alt. Coll. Werdermann 303! Type! (AMES).

The specimens of this new species are commonly found in herbaria under *Spiranthes* or *Brachystele unilateralis*. *Brachystele unilateralis*, chosen as lectotype for the genus, however, is

very distinct in the columnar structure, especially in the rostellum, from those found in Odontorhynchus. Moreover, in *B. unilateralis* the leaves are linear, fasciculate, whereas in *O. variabilis* they are always lanceolate to lanceolate-ovate and petiolate.

The material available to me suggests that there are perhaps two or three different, closely related species hiding under *O. variabilis*, judging from the different terminal lobes of the lips and the coloration of the flowers. More field observations than are currently available are needed for the understanding of this complex.

In herbarium material I was able to ascertain already that plants described as *Spiranthes chilensis* A. Rich. are indeed distinct from *O. variabilis* in the shape of the lip which is quite apparent also on Richard's original drawing preserved in Paris.

Pteroglossa luteola Garay, *sp. nov.*

Plantae terrestres, elatae, usque ad 28 cm. altae; radicibus fasciculatis, stipitato-fusiformibus, elongatis pubescentibus; foliis basilaribus, e cuneata basi obovato-oblanceolatis, subpetiolatis, obtusis, glabris, usque ad 23 cm. longis, 5.5 cm latis; scapo erecto, laxe plurivaginato, supra laxe paucifloro, usque ad 28 cm. longo; bracteis foliaceis, ovato-lanceolatis, subacuminatis, usque ad 2.5 cm. longis, 0.7 cm. latis; floribus conspicuis, pallide luteolis; sepalo postico lanceolato-oblongo, acuto, concavo, extus pubescenti, usque ad 18 mm. longo, 5 mm. lato; sepalis lateralibus oblique ellipticis, acutis, basi decurrentibus, extus breviter pubescentibus, usque ad 32 mm. longis, 7 mm. latis; petalis e cuneata basi oblique rhombeis, acutis, basi decurrentibus, usque ad 23 mm. longis, 6 mm. latis; labello e cuneata basi obovato-oblanceolato, supra apicem sublobato, apice ipso reflexo, crenulato, basin margine calloso, usque ad 28 mm. longo, 10 mm. lato; columna plus minusque arcuata, facie puberula, basi longe decurrentia, usque ad 25 mm. longa; ovario fusiformi, subsessili, usque ad 25 mm. longo.

Argentina: Estancia "Santa Teresa", Depto. Mburucuyá, Prov. Corrientes. Coll. Pedersen 8336! Type! (AMES).

Duplicates of the type collection were identified by Dr. Maevia Correa as *Centrogenium roseoalbum* (Rchb.f.) Schltr. and distributed under this name by Botanical Museum of the Univeristy, Copenhagen.

Pteroglossa rhombipetala Garay, *sp. nov.*

Plantae terrestres, usque ad 40 cm. altae; radicibus fasciculatis, crassiusculis, pubescentibus; foliis basalibus, 3-nis, e cuneata basi ellipticis vel obovato-ellipiticis, obtusis, usque ad 20 cm. longis, 7 cm. latis; scapo erecto, dimidio inferiori vaginato, dimidio superiori laxe paucifloro; bracteis ovato-cucullatis, acutis, usque ad 3 cm. longis; floribus satis magnis, viridialbis, extus breviter pubescentibus; sepalo postico oblongo-lanceolato, acuto, concavo, usque ad 18 mm. longo, 4 mm. lato; sepalis lateralibus oblique oblongo-ligulatis, basi longe decurrentibus, acutis vel obtusis, usque ad 30 mm. longis, 5 mm. latis; petalis rhombeis, basi oblique longeque decurrentibus, apice obtusis, usque ad 22 mm. longis, 4 mm. latis; labello e cuneata basi obovato-oblanceolato, ad tertiam partem apicalem obscure lobulato, apice ipso obtuso, margine juxta basin crasso incrassato, usque ad 35 mm. longo, 8 mm. lato; columna leviter arcuata, facie puberula, usque ad 10 mm. longa; ovario arcuato-clavato, haud torto, usque ad 20 mm. longo.

Paraguay: Itapé. Coll. Schade s.n.! Type! (AMES). Also **Argentina:** Prov. Santa Fé, Villa Guillermina. Coll. Meyer 2624! (AMES).

Sauroglossum Schweinfurthianum Garay, *sp. nov.*

Plantae terrestres, elatae, usque ad 45 cm. altae; radicibus fasciculatis, crasse tuberosis, pubescentibus; foliis sub anthesin absentibus; scapo erecto, laxe paucivaginato, apice dense multifloro, spica ovoidea vel subcylindrica, usque ad 6 cm. longa; bracteis lanceolatis, acuminatis, 1 cm. longis, sursum decrescentibus; floribus aurantiacis, satis parvis; sepalo postico oblongo-ligulato, acuto vel obtuso, extus sparse puberulo, usque ad 7 mm. longo, 2.5 mm. lato; sepalis lateralibus obliquis, linearioblongis, supra basin leviter constrictis, obtusis, usque ad 8 mm.

longis, 2 mm. latis; petalis oblique spathulato-obovatis, obtusis, usque ad 7 mm. longis, 2mm. latis; labello e canaliculata basi subquadrato-ovato, apice undulato-crispato, usque ad 7 mm. longo, 4 mm. lato; columna brevi, 3 mm. alta; ovario cylindrico, puberulo, usque ad 6 mm. longo.

Peru: Depto. Huánuco, Llata. Coll. Macbride & Featherstone no. 2273! Type! (AMES); Chinchapalca, 5 miles above Mito. Coll. Macbride & Featherstone no. 1589! (AMES); Depto Junín, Huariaca. Coll. Asplund no. 11963! (S).

The above cited specimens have been cited as *Spiranthes Lechleri* (Schltr.) Schweinf. in Orchids of Peru by Charles Schweinfurth.

KEY TO GENERA

1. Stigmata terminal, on top of a truncate or subtruncate column and at right angle to rostellum; hence, they appear horizontal 2
1a. Stigmata anterior, either beneath the rostellum or on both sides of it; hence, they appear vertical 8
2. Flowers not resupinate, hence, lip uppermost; dorsal sepal connate with lateral sepals for a neglibible distance at base and adnate to filament of anther; clinandrium formed by a narrow, hyaline margin, free from filament of anther; pollinia with distinct caudicles ..... **1. Nothostele**
2a. Flowers resupinate, hence, lip lowermost; dorsal sepal free from lateral sepals; clinandrium well-developed, fused with filament of anther; pollinia without caudicles 3
3. Petals free from dorsal sepal; rostellum deeply bifid to bicuspidate; plants with a single, sessile, cordate-subrotund leaf enveloping the stem ..... **2. Discyphus**
3a. Petals agglutinate with dorsal sepal; rostellum not divided; plants either aphyllous at flowering time or with well-developed, cuneate to petiolate leaves 4
4. Rostellum soft, short, broadly triangular with an apical fovea; lip fleshy, cochleate in front .... **3. Sauroglossum**
4a. Rostellum rigid, more or less cartilaginous, sharply pointed; lip membranaceous, never cochleate in front 5

5. Lateral sepals with column-foot do not form an observable mentum; column-foot very short, subequal in length to column; lip pandurate ..... **4. Lyroglossa**

5a. Lateral sepals with free part of column-foot form either a mentum or a tubular, spur-like extension; column-foot much longer than column; lip never pandurate 6

6. Stigmata bilobed, more or less separated from one another by terminal edge of a distinct fold running full length on face of column 7

6a. Stigmata confluent, semicircular on top of terete column ..... **5. Sacoila**

7. Lateral sepals with column-foot form a short, protruding chin, never spur-like ..... **6. Pteroglossa**

7a. Lateral sepals with free part of column-foot form a pendulous, spur-like process ..... **7. Eltroplectris**

8. Stigmata 2, lateral on both sides of rostellum, large saddle-shaped, surpassing the foveate-truncate rostellum in height; petals free from dorsal sepal; lip with a deeply biparted, coarsely lacerate, terminal lobe; flowers always resupinate, *i.e.*, the lip is uppermost in position ..... **8. Pseudocranichis**

8a. Stigmata 2, always beneath the terminal rostellum; petals agglutinate with dorsal sepal; lip always without a coarsely lacerate terminal lobe; flowers resupinate, *i.e.*, the lip is in lowermost position; this position may be obtained either through twisting of the ovary, arching of the inflorescence, or through the pendulous habit of the plant 9

9. All three sepals connate basally, forming a distinct tube-like, often cylindrical nectary 10

9a. Dorsal sepal free from, or rarely connate a negligible distance with lateral sepals, never forming a cylindrical nectary, in exceptional cases, it may be likened to a shallow cup 17

10. Column free from sepaline tube; rostellum elongate, oblong-linear; claw of lip short, free from sepaline tube ..... **9. Cyclopogon**

10a. Column partially adnate to dorsal sepal; rostellum short, triangular in outline; lip either sessile or with a long claw which is adnate to sepaline tube 11

11. Free portion of column inclined; clinandrium basket-like with free, lacerate-dentate sides not fused with sides of stigmatic cavity ..... **10. Manniella**

11a. Free portion of column suberect; clinandrium infundibuliform with entire sides adnate to column 12

12. Flowers very large; rostellum acicular in center of a large, deeply bilobed, blunt plate; stigmata confluent ..... **11. Cybebus**

12a. Flowers never very large, mostly medium to small; rostellum laminar, without a deeply bilobed plate 13

13. Plants miniature with ciliate to hairy leaves, growing on branches of trees; lateral sepals didymous to ventricose at base; median nerve of sepals always cristate-carinate dorsally ..... **12. Eurystyles**

13a. Plants large, aphyllous or with glabrous leaves, terrestrial; lateral sepals never didymous at base; median nerve of sepals always ecristate dorsally 14

14. Rostellum emarginate; base of lip with marginal thickenings; plants stout; inflorescence more or less densely many-flowered ..... **13. Aulosepalum**

14a. Rostellum entire, triangular; base of lip auriculate to sagittate 15

15. Plants stout; leaves, rarely absent during flowering time, with tubular, adpressed, imbricating, vaginate sheaths forming a prominent, pillar-like base below spreading petioles or blades; rostellum short, triangular with an apical fovea, easily ruptured; stigmata free to approximate; claw of lip short ..... **14. Kionophyton**

15a. Plants small, slender; leaves when present, basal without a pillar-like base; rostellum without an apical fovea; claw of lip rather long 16

16. Plants autogamous with inconspicuous, decumbent rhizome; leaves basal, present during anthesis; column-foot short, oblique on top of ovary; rostellum short, obtuse; stigmata free to approximate ..... **15. Helonoma**

16a. Plants allogamous with fasciculate, tuberous roots; leaves absent during anthesis; column-foot elongate, long-decurrent on side of ovary; rostellum elongate, acute to sub-

acuminate; stigmata confluent ..... **16. Gularia**

17. Anther bivalvate, often deeply cordate, emarginate at apex, much surpassing the rostellum, during anthesis becomes flattened and arcuately curved backwards; stigmata always confluent; rostellum emarginate, hardly differentiated, with a dorsal median toothlet which often is very much reduced in size or obscure altogether ..... **17. Mesadenus**

17a. Anther entire, rather deeply concave to umbonate, as long as, or somewhat surpassing rostellum, as a rule never curved backwards; stigmata free to approximate or transversely confluent; rostellum variously developed, always distinguishable 18

18. Column ballooned out in front due to inflated clinandrium 19

18a. Column never ballooned out in front 20

19. Rostellum short, bilobed; lip sagittate at base; stigmata approximate ..... **18. Beloglottis**

19a. Rostellum elongate, entire; lip more or less auriculate at base; stigmata confluent ..... **19. Physogyne**

20. Stigmata situated on a deeply cleft, biparted cartilaginous plate; rostellum narrowly triangular, dorsal to plate, in center behind dividing cleft ..... **20. Thelyschista**

20a. Stigmata always on same plane with rostellum 21

21. Rostellum divided into two distinct segments 22

21a. Rostellum undivided with an entire, pointed, truncate, emarginate or denticulate apex 23

22. Inflorescence arranged in a single or double spiral; dorsal sepal free from column; lateral sepals free; rostellum bifid or bidentate with sharply pointed or filiform segments ..... **21. Spiranthes**

22a. Inflorescence quaquaversal or subsecund; dorsal sepal halfway adnate to column; lateral sepals connate at base; rostellum bilobed with broad, obtuse lobules ....**22. Galeottiella**

23. Rostellum rigid, more or less cartilaginous 24

23a. Rostellum soft, always pliable, laminar to filiform ... 31

24. Rostellum broadly triangular, acute at the more or less obscurely 3-lobulate or 3-dentate apex ..... **23. Odontorrhynchus**

24a. Rostellum linear-lanceolate to almost acicular, sharply-pointed or with a small, lateral tooth at base on each side 25

25. Column footless, at most with an oblique base on top of ovary 26

25a. Column with a distinct, decurrent foot on side of ovary 29

26. Flowers basally enlarged, urnlike; sepals at base on both sides become separated and form an opening like small windows; lateral sepals adnate to claw of lip and together display a prominent mentum ..... **24. Dithyridanthus**

26a. Flowers neither enlarged basally, nor do sepals form windows; mentum at best rudimentary, obscure 27

27. Column footless, its base arcuately confluent with claw of lip which is without any calli or marginal thickenings; lip segmented into a short, cup-shaped hypochile and an elongte, conduplicate, apically recurved epichile ..... **25. Cotylolabium**

27a. Column with a distinct, oblique base on top of ovary, sharply parallel with calliferous base of lip; lip not segmented 28

28. Inflorescence subcorymbose, cernuous; lip unguiculate with large, thickened auricles; column elongate, slender ..... **26. Coccineorchis**

28a. Inflorescence spicate, erect; lip sessile, calliferous along margins at base; column short, stout ..... **27. Stenorrhynchos**

29. Plants miniature with few-flowered inflorescences; facultative epiphytes; rostellum unequally 3-dentate, the median tooth always longer; lip broadly concave to gibbose at base ..... **28. Lankesterella**

29a. Plants large with an elongate, cylindrical, many-flowered inflorescence; facultative geophytes; rostellum entire or obscurely 3-dentate, always linear; lip sagittate or conduplicate at base 30

30. Flowers small in a rather loosely-flowered, often spirally twisted rachis; stigmata approximate; lip sagittate at base; rostellum linear-subulate ..... **29. Mesadenella**

30a. Flowers medium in an allsided, densely-flowered rachis; stigmata confluent or V-shaped; lip conduplicate at base, more or less sigmoid; rostellum on each side at base with a small lateral tooth ..... **30. Skeptrostachys**

31. Rostellum very short, discernible only as a thin, transverse line above the edges of the stigmata, with a distinct membranaceous fovea at the tip; if membrane breaks or disintegrates in drying, rostellum appears to be emarginate in middle 32

31a. Rostellum as long as, or longer than wide, prominent, variously shaped 33

32. Dorsal sepal free to base of column; petals at most with a somewhat oblique base; stigmata approximate to free; fovea of truncate rostellum always breaks during drying ..... **31. Brachystele**

32a. Dorsal sepal partially adnate to column; petals decurrent on column-foot; stigmata confluent, subquadrate; fovea of rostellum commonly persistent upon drying .... **32. Microthelys**

33. Column with an obliquely extended base on top of ovary 34

33a. Column with a distinct foot decurrent on side of ovary, either manifested externally or completely hidden internally 39

34. Lip unguiculate with a sagittate, auriculate or cordate base 35

34a. Lip sessile, either excavate or conduplicate-channelled at base 36

35. Flowers subglobose; lip cordate, cochleate with a transverse ridge above base; rostellum trapezoid, emarginate; stigmata confluent, reniform ..... **33. Pseudogoodyera**

35a. Flowers elongate; lip never cochleate and without basal transverse ridge; rostellum linear-oblong to variously triangular; stigmata free to approximate ..... **34. Beadlea**

36. Stem ascending from a rhizomatous or subrhizomatous base with fleshy tuber-like roots originating from distant to more or less approximate nodes; Stigmata confluent; rostellum oblong to ligulate, excised at apex .... **35. Hapalorchis**

36a. Stem caespitose with fasciculate roots or tubers; stigmata either confluent or separate; rostellum never oblong or ligulate, or excised at apex 37

37. Plants delicate; sepals connivent, subparallel; dorsal sepal free from column; lateral sepals oblique, sessile; column cylindric 38

37a. Plants robust; sepals divaricately spreading; dorsal sepal adnate basally to back of column; lateral sepals with a short, didymous base; rostellum arrect, obovate to angular ..... **36. Buchtienia**

38. Stigmata 2, separate; rostellum subquadrate-flabellate, truncate, sulcate in middle; roots fleshy, fasciculate, geophytes ..... **37. Stigmatosema**

38a. Stigmata 2, confluent; rostellum narrowly triangular, esulcate in middle; base of plants with a single tuber; growing among mosses on tree trunks ..... **38. Stalkya**

39. Column-foot embedded full length internally in ovarian tissue and with it the more or less connate lateral sepals form a prominent, internal nectary or cuniculus without any externally observable line of adnation .... **39. Sarcoglottis**

39a. Column-foot decurrent on ovarian wall and with it the free or partially connate lateral sepals form an externally observable line of adnation 40

40. Dorsal sepal free from back of column; lateral sepals basally connate into a ventricose, saccate or spur-like vesicle which is manifested often in a pronounced mentum; stigmata 2, separate to variously approximate; lip commonly sagittate at base, rarely auriculate ....**40. Pelexia**

40a. Dorsal sepal partially adnate to back of column; lateral sepals never form a ventricose or saccate base, nor a mentum; stigmata 2, confluent; lip either unguiculate with auriculate to cordate base, but never sagittate or com-

monly conduplicate to excavate 41

41. Lip with a distinct, flat claw without thickened margins and with a calliferous or thickened, auriculate to cordate base; petals straight with an oblique, but never decurrent base; rostellum from a narrowly cuneate base arcuately linear-triangular, acuminate ..... **41. Schiedeella**

41a. Lip conduplicate to excavate at base with more or less thickened margins; petals sinuous with a decurrent base; rostellum without arcuate sides 42

42. Plants completely invested with diaphanous sheaths; rostellum from a broad base variously triangular, obtuse to acuminate ..... **42. Deiregyne**

42a. Plants without diaphanous sheaths; rostellum either linear-oblong or filiform 43

43. Inflorescence few-flowered, secund; flowers horizontal; lip gibbose-excavate at base; rostellum filiform ..... **43. Funckiella**

43a. Inflorescence many-flowered, quaquaversal, conical-thyrsoid; flowers erect; lip navicular with channelled base; rostellum linear-oblong ..... **44. Dichromanthus**

INDEX TO GENERA AND SPECIES

Acraea Lindl.
  Widgreni Rchb.f. = Brachystele Widgreni (Rchb.f.) Schltr.

Adnula Raf.
  petiolaris Raf. = Pelexia adnata (Sw.) Spreng.

Aetheria Bl. ex Endl.
  caespitosa Lindl. = Lankesterella caespitosa (Lindl.) Hoehne

Arethusa L.
  picta Anders. = Sarcoglottis acaulis (J.E.Sm.) Schltr.

Aristotelea Lour.
  spiralis Lour. = Spiranthes sinensis (Pers.) Ames

Aulosepalum Garay, gen. nom. nov.
Basionym: *Gamosepalum* Schltr. in Beih. Bot. Centralbl. 37(2): 429, 1920, not Hausskn. 1897.
Etymology: *Aulos* = tube and *sepalum* = sepal, in reference to the sepaline tube.

Sepals subequal, connate to middle, forming a distinct, more or less cylindrical tube which is suberect to perpendicular on top of ovary. Petals connivent with dorsal sepal, basally decurrent. Lip with a long claw, adnate to tube, lamina with marginal thickenings at base. Column half-way adnate to dorsal sepal, free portion suberect, basally produced in a distinct foot; stigmata 2, confluent or closely approximate; rostellum short, triangular in outline, emarginate, soft; clinandrium funnel-shaped. Anther ovate-cucullate, obtuse; pollinia with a round viscidium. Ovary cylindric, somewhat twisted.

Plants stout, erect, xerophytic. Roots fasciculate, fusiform. Leaves, when present, basal, long-petiolate. Stem completely enclosed by more or less chartaceous, hyaline sheaths. Inflorescence many-flowered. Flowers of medium size, erect on top of ovary.

TYPE: *Spiranthes tenuiflora* Greenm.

Four species native to Mexico and Guatemala.

Index to species

Aulosepalum hemichrea (Lindl.) Garay, comb. nov.
Basionym: Spiranthes hemichrea Lindl., Gen. and Sp. Orch. Pl. 473, 1840.
Aulosepalum Nelsonii (Greenm.) Garay, comb. nov.
Basionym: Spiranthes Nelsonii Greenm. in Proc. Amer. Acad. Sci. 35: 307, 1900.
Aulosepalum ramentaceum (Lindl.) Garay, comb. nov.
Basionym: Spiranthes ramentacea Lindl. in Ann. Nat. Hist. 4: 384, 1840.
Aulosepalum tenuiflorum (Greenm.) Garay, comb. nov.
Basionym: Spiranthes tenuiflora Greenm. in Proc. Amer. Acad. Sci. 35: 308, 1900.

Beadlea Small, Flora SE United States 319, 1903.
Etymology: In honor of Chauncey Delos Beadle (1866 1950), an American botanist.

Sepals free, subparallel; lateral sepals oblique, with base of column forming a short but obscure mentum. Petals connivent with dorsal sepal. Lip unguiculate, sagittate, auriculate or cordate at base, lateral margins agglutinate with sides of column. Column erect, free from dorsal sepal, more or less elongate, with a short, oblique base on top of ovary; stigmata 2, free to approximate; rostellum undivided, soft, pliable, longer than wide, linear-oblong to variously triangular. Anther concave-cucullate; pollinia clavate, with a small viscidium. Ovary cylindric to fusiform, slightly twisted, sessile.

Terrestrial, slender plants with fasciculate, fusiform roots. Leaves basal, rosulate, commonly petiolate. Stem erect, variously bracteolate, terminated by a loosely- to densely-flowered spike. Flowers small.

TYPE: *Spiranthes Storeri* Chapm.

54 species native to the tropical and subtropical regions of the New World.

Index to species

Beadlea alexandrae (Krzl.) Garay, comb. nov.
Basionym: Spiranthes alexandrae Krzl. in Svensk Vet. Akad. Handl. 46(10): 33, 1911.
Beadlea aprica (Lindl.) Garay, comb. nov.
Basionym: Spiranthes aprica Lindl., Gen. and Sp. Orch. Pl. 469, 1840.
Beadlea argyrifolia (Barb.Rodr.) Garay, comb. nov.
Basionym: Spiranthes argyrifolia Barb.Rodr., Gen. et Sp. Orch. Nov. 1: 183, 1877.
argyrotaenia (Schltr.) Garay
Beadlea bicolor (Ker-Gawl.) Garay, comb. nov.
Basionym: Neottia bicolor Ker-Gawl. in Bot. Reg. 10: t. 794, 1824.
Beadlea bidentata (Barb.Rodr.) Garay, comb. nov.
Basionym: Cyclopogon alpestris var. bidentata Barb.Rodr., Gen. et Sp. Orch. Nov. 2: 283, 1881.
bifida (Ridl.) Garay & Dunsterv. = Helonoma bifida (Ridl.) Garay
Beadlea calophylla (Barb.Rodr.) Garay, comb. nov.
Basionym: Spiranthes calophylla Barb. Rodr., Gen. et Sp. Orch. Nov. 1: 182, 1877.
Beadlea casanaënsis (Schltr. ex Mansf.) Garay, comb. nov.
Basionym: Cyclopogon casanaënsis Schltr. ex Mansf. in Fedde, Rep. 27: 32, 1929.

Beadlea cearensis (Barb.Rodr.) Garay, comb. nov.
Basionym: Cyclopogon cearensis Barb. Rodr., Gen. et Sp. Orch. Nov. 2: 283, 1881.
comosa (Rchb.f.) Hamer & Garay
Beadlea congesta (Vell.) Garay, comb. nov.
Basionym: Serapias congesta Vell., Fl. Flum. Ic. 9: t.54, 1831.
cranichoides (Griseb.) Small
Beadlea diversifolia (Cogn.) Garay, comb. nov.
Basionym: Spiranthes diversifolia Cogn. in Mart., Fl. Bras. 3(6): 543, 1906.
Beadlea Dusenii (Schltr.) Garay, comb. nov.
Basionym: Cyclopogon Dusenii Schltr. in Fedde, Rep. 16: 323, 1920.
Beadlea Dutraei (Schltr.) Garay, comb. nov.
Basionym: Cyclopogon Dutraei Schltr. in Fedde, Rep. Beih. 35: 30, 1925.
elata (Sw.) Small
Beadlea eldorado (Linden & Rchb.f.) Garay, comb. nov.
Basionym: Spiranthes eldorado Linden & Rchb.f. in Bot. Zeit. 15: 157, 1857.
Beadlea elegans (Hoehne) Garay, comb. nov.
Basionym: Cyclopogon elegans Hoehne in Arq. Bot. Est.S.Paulo n.s. 1(6): 132, 1944.
elliptica Garay
epiphytica Dodson
Beadlea Eugenii (Rchb.f. & Warm.) Garay, comb. nov.
Basionym: Spiranthes Eugenii Rchb.f., Otia Bot. Hamb. 2: 84, 1881.
Beadlea glabrescens (Hashimoto) Garay, comb. nov.
Basionym: Spiranthes glabrescens Hashimoto in Journ. Jap. Bot. 46: 175, 1971.
Beadlea goodyeroides (Schltr.) Garay, comb. nov.
Basionym: Spiranthes goodyeroides Schltr. in Fedde, Rep. 10: 448, 1911.
gracilis (Schltr.) Garay
Beadlea graciliscapa (Schltr.) Garay, comb. nov.
Basionym: Cyclopogon graciliscapus Schltr. in Anex. Mem. Inst. Butantan 1(4): 23, 1922.
Beadlea Hatschbachii (Schltr.) Garay, comb. nov.
Basionym: Cyclopogon Hatschbachii Schltr. in Fedde, Rep. 23: 34. 1926.
Hennisiana (Sandt) Garay
Beadlea iguapensis (Schltr.) Garay, comb. nov.
Basionym: Cyclopogon iguapensis Schltr. in Anex. Mem. Inst. Butantan 1(4): 25, 1922.
inaequilatera (Poepp. & Endl.) Garay
Beadlea itatiaiensis (Krzl.) Garay, comb. nov.
Basionym: Spiranthes itatiaiensis Krzl. in Svensk Vet. Akad. Handl. 46(10): 36, 1911.
Beadlea laxiflora (Ekman & Mansf.) Garay, comb. nov.
Basionym: Cyclopogon laxiflorus Ekman & Mansf. in Arkiv f. Bot. 22A: 11, 1929.
Lindleyana (Link,Kl. & Otto) Garay & Dunsterv.

Beadlea longibracteata (Barb.Rodr.) Garay, comb. nov.
Basionym: Spiranthes longibracteata Barb. Rodr., Gen. et Sp. Orch. Nov. 1: 185, 1877.
Beadlea luteo-alba (Rich. & Gal.) Garay, comb. nov.
Basionym: Spiranthes luteo-alba Rich. & Gal. in Ann. Sci. Nat. ser. 3, 3: 32, 1845.
Millei (Schltr.) Garay
miradorensis (Schltr.) Garay & Dunsterv.
Beadlea multiflora (Schltr.) Garay, comb. nov.
Basionym: Cyclopogon multiflorus Schltr. in Anex. Mem. Inst. Butantan 1(4): 27, 1922.
Beadlea oligantha (Hoehne) Garay, comb. nov.
Basionym: Spiranthes oligantha Hoehne in Rev. Mus. Paulist. 10: 442, 1919.
olivacea (Rolfe) Garay
organensis Pabst
peruviana (Presl) Garay
plantaginea Garay
Beadlea prasophylloides Garay, nom. et stat. nov.
Basionym: Spiranthes Prasophyllum var. cleistogama Ames & Correll in Bot. Mus. Leafl. 10: 65, 1942.
Prasophyllum (Rchb.f.) Hamer & Garay
Rimbachii (Schltr.) Garay
Beadlea saccata (Rich. & Gal.) Garay, comb. nov.
Basionym: Spiranthes saccata Rich. & Gal. in Ann. Sci. Nat. ser. 3, 3: 32, 1845.
Storeri (Chapm.) Small = Beadlea cranichoides (Griseb.) Small
Beadlea subalpestris (Schltr.) Garay, comb. nov.
Basionym: Cyclopogon subalpestris Schltr. in Fedde, Rep. Beih. 35: 32, 1925.
Beadlea taquaremboënsis (Barb.Rodr.) Garay, comb. nov.
Basionym: Stenorrhynchus taquaremboënsis Barb.Rodr. in Contr. Jard. Bot. Rio 1: 68, 1902.
Beadlea trifasciata (Schltr.) Garay, comb. nov.
Basionym: Cyclopogon trifasciatus Schltr. in Fedde, Rep. Beih. 35: 33, 1925.
Beadlea truncata (Lindl.) Garay, comb. nov.
Basionym: Spiranthes truncata Lindl., Gen. and Sp. Orch. Pl. 470, 1840.
Beadlea variegata (Barb.Rodr.) Garay, comb. nov.
Basionym: Cyclopogon variegatus Barb. Rodr., Gen. et Sp. Orch. Nov. 2: 282, 1881.
Beadlea venusta (Barb.Rodr.) Garay, comb. nov.
Basionym: Stenorrhynchus venustus Barb.Rodr. in Contr.Jard. Bot. Rio 1: 49, 1901.
Beadlea vittata (Dutra ex Pabst) Garay, comb. nov.
Basionym: Cyclopogon vittatus Dutra ex Pabst in Sellowia 10: 128, 1959.
Beadlea Warmingii (Rchb.f.) Garay, comb. nov.
Basionym: Spiranthes Warmingii Rchb.f., Otia Bot. Hamb. 2: 84, 1881.

Beloglottis Schltr. in Beih. Bot. Centralbl. 37(2): 364, 1920.

Etymology: *Belos* = dart and *glotta* = tongue, in reference to the shape of the lip of the type species.

Sepals subparallel, essentially free, occasionally connate to a negligible distance akin to a shallow cap, the apices arcuately spreading; lateral sepals with an oblique, subdecurrent base. Petals parallel and agglutinate with dorsal sepal, short-decurrent at base. Lip distinctly unguiculate, the claw adnate to base of lateral sepals, lamina canaliculate with sagittate base; lateral margins in middle agglutinate with sides of column. Column rather short, due to inflated clinandrium basally ballooned out, partly adnate to dorsal sepal, basally produced into a short, oblique foot without forming an ovarian spur or mentum; stigmata 2, anterior, touching each other in middle; rostellum short, erect, bilobed, bifid or distinctly bidentate. Anther more or less ovate, concave, acute, slightly cordate at base; pollinia clavate with narrowly elliptic viscidium tightly inserted between rostellar lobes. Ovary slender, cylindric, sessile.

Terrestrial plants with fasciculate, puberulent roots. Leaves several, basal, petiolate. Scape slender, erect, bracteolate, terminated by a loosely to densely many-flowered spike. Flowers small to almost inconspicuous.

TYPE: *Spiranthes costaricensis* Rchb.f.

Seven species native to tropical and subtropical regions of the New World.

Index to species

bicaudata (Ames) Garay
boliviensis Schltr.
costaricensis (Rchb.f.) Schltr.
ecallosa (A. & S.) Hamer & Garay
Hameri Garay
mexicana Garay
Beloglottis subpandurata (A. & S.) Garay, comb. nov.
Basionym: Spiranthes subpandurata A. & S., Sched. Orch. 8: 4, 1925.

Brachystele Schltr. in Beih. Bot. Centralbl. 37(2): 370, 1920.

Etymology: *Brachys* = short and *stele* = pillar, column, in reference to the short column.

Sepals free to base, subparallel; lateral sepals with an oblique base, together with short, incurved column-foot form a small, obtuse mentum. Petals agglutinate to dorsal sepal, at most with an oblique base. Lip sessile, arcuately conduplicate with a recurved apex, basally with thickened margins; lamina agglutinate in middle to sides of column. Column short, widened toward apex, basally produced in a short, incurved foot; stigmata 2, approximate to free, rostellum soft, undivided, very short, discernible only as a thin, truncate line above the edges of stigmata, with a distinct, membranaceous fovea of a thin membrane in the center which always breaks during drying, hence rostellum appears to be emarginate or incised in middle. Anther short, concave, rotund; pollinia short, clavate with a small, roundish viscidium tightly fitting into rostellar fovea. Ovary more or less arcuately cylindric, somewhat twisted.

Terrestrial plants, commonly leafless during anthesis. Roots fasciculate, fleshy, fusiform, often stipitately fusiform. Leaves commonly absent during anthesis, when present, basal, petiolate. Stem erect, vaginate, terminated by a cylindric, densely many-flowered spike, rarely loosely secund. Flowers small to minute.

LECTOTYPE: *Ophrys unilateralis* Poir. [Cabrera in DAGI 1(6): 16, 1942]

13 species native mainly to South America, especially Brazil and adjacent countries, with one species in Central America and the West Indies.

Index to species

aguacatensis (Rchb.f.) Schltr. = Brachystele guayanensis (Lindl.) Schltr.
Arechavaletae (Krzl.) Schltr.
atramentaria (Krzl.) Schltr. = Brachystele Widgrenii (Rchb.f.) Schltr.
bracteosa (Lindl.) Schltr.
Brenesii (Schltr.) Schltr. = Brachystele guayanensis (Lindl.) Schltr.
Burkartii Correa
camporum (Lindl.) Schltr.
chlorops (Rchb.f.) Schltr. =Odontorrhynchus chlorops (Rchb.f.) Garay
cyclochila (Krzl.) Schltr.
cycloglossa (Krzl.) Schltr., sphalm. = Brachystele cyclochila (Krzl.) Schltr.
delicatula (Krzl.) Schltr.

dilatata (Lindl.) Schltr.
guayanensis (Lindl.) Schltr.
Hatschbachii Pabst = Stigmatosema Hatschbachii (Pabst) Garay
Hoehnei Pabst = Brachystele Ulaei (Cogn.) Schltr.
icmadophila (Barb.Rodr.) Schltr. ex Pabst, nomen = Spiranthes icmadophila Barb. Rodr.
Lechleri Schltr. = Brachystele unilateralis (Poir.) Schltr.
longiflora Schltr. = Sauroglossum longiflorum (Schltr.) Garay
Nuil (L.C.Rich.) Schltr. = Brachystele unilateralis (Poir.) Schltr.
Brachystele pedicellata (Cogn.) Garay, comb. nov.
Basionym: Spiranthes pedicellata Cogn. in Mart., Fl. Bras. 3(4): 210, 1895.
spiranthoides Schltr. = Brachystele cyclochila (Krzl.) Schltr.
subfiliformis (Cogn.) Schltr.
Ulaei (Cogn.) Schltr.
unilateralis (Poir.) Schltr.
Widgrenii (Rchb.f.) Schltr.

Buchtienia Schltr. in Fedde, Rep. 27: 33, 1929.

Etymology: In honor of Otto Buchtien (1859 – 19..), a German plant collector and Director of Museo National in La Paz, Bolivia.

Dorsal sepal erect, free, partially adnate to back of column; lateral sepals divaricate, connate at base and forming a more or less didymous sac with a short column-foot. Petals shorter than dorsal sepal to which the inner margins agglutinate, base decurrent on column-foot. Lip sessile, inarticulate, smaller than other perianths; the broadly subquadrate claw with thickened margins, more or less subsaccate, firmly fused with column-foot and enclosed in the sac-like base of the lateral sepals; blade 3-lobed, lateral lobes erect, midlobe reflexed. Column short, glabrous, terete, somewhat sigmoid, form a narrow pedicellate base abruptly expanding upwards into an urceolate clinandrium, basally produced in an oblique foot on top of ovary; stigmata 2, approximate to confluent, transversely elliptic, marginate; rostellum undivided, soft, laminar, arrect, obovate to angular, esulcate in middle (never 3-lobed as originally reported). Anther erect to somewhat incumbent, umbonate; pollinia obovoid with a small viscidium. Ovary sessile.

Terrestrial, large plants. Roots fasciculate, tuberous. Leaves basal, several, long-petiolate. Scape much surpassing the leaves,

remotely sheathed, terminated by a long, loosely many-flowered spike. Flowers small, resupinate.

TYPE: *Buchtienia boliviensis* Schltr.

Three species native to Ecuador, Peru, Bolivia and Brazil.

Index to species

boliviensis Schltr.
ecuadorensis Garay
rosea Garay

Centrogenium Schltr.
acianthiforme (Rchb.f. & Warm.) Hoehne = Nothostele acianthiformis (Rchb.f. & Warm.) Garay
calcaratum (Sw.) Schltr. = Eltroplectris calcarata (Sw.) Garay & Sweet
Cogniauxianum Schltr. = Eltroplectris Cogniauxiana (Schltr.) Pabst
janeirense Porto & Brade = Eltroplectris janeirensis (Porto & Brade) Pabst
Kuhlmannianum Hoehne = Eltroplectris Kuhlmanniana (Hoehne) Pabst
longicornu (Cogn.) Schltr. = Eltroplectris longicornu (Cogn.) Pabst
luridum Correa = Pteroglossa lurida (Correa) Garay
macrophyllum Schltr. = Eltroplectris macrophylla (Schltr.) Pabst
olivaceum (Rolfe) Schltr. = Pelexia olivacea Rolfe
Radmakeri Ruschi & LaGasa = Eltroplectris calcarata (Sw.) Garay & Sweet
roseoalbum (Rchb.f.) Schltr. = Eltroplectris roseoalba (Rchb.f.) Hamer & Garay
Schlechteranum Porto & Brade = Eltroplectris Schlechterana (Porto & Brade) Pabst
setaceum (Lindl.) Schltr. = Eltroplectris calcarata (Sw.) Garay & Sweet
trilobum (Lindl.) Schltr. = Eltroplectris triloba (Lindl.) Pabst

Cladobium Schltr., not Lindl.
ceracifolium (Barb. Rodr.) Schltr. = Lankesterella ceracifolia (Barb.Rodr.) Mansf.
costaricense Schltr. = Lankesterella orthantha (Krzl.) Garay
epiphytum (Barb.Rodr.) Schltr. = Lankesterella caespitosa (Lindl.) Hoehne
gnomus (Krzl.) Schltr. = Lankesterella gnomus (Krzl.) Hoehne
longicolle (Cogn.) Schltr. = Lankesterella longicollis (Cogn.) Hoehne
majus Hoehne & Schltr. = Lankesterella ceracifolia (Barb.Rodr.) Mansf.
oliganthum Hoehne & Schltr. = Lankesterella cercacifolia (Barb.Rodr.) Mansf.
pilosum (Cogn.) Schltr. = Lankesterella pilosa (Cogn.) Hoehne
Spannagelianum Hoehne & Brade = Lankesterella Spannageliana (Hoehne & Brade) Hoehne

Coccineorchis Schltr. in Beih. Bot. Centralbl. 37(2): 434, 1920.

Etymology: *Kokkinos* = scarlet and *orchis* = orchid, in reference to color of the flowers, especially of the type species.

Sepals free, similar, subparallel; lateral sepals with an obliquely inserted base on top of the ovary without forming an observable mentum. Petals agglutinate with dorsal sepal. Lip distinctly unguiculate, conduplicate with an arcuate apex, basally prominently auriculate; margins of lamina in middle agglutinate with sides of column. Column slender, elongate, pubescent in front, free from dorsal sepal, with a distinct, oblique base on top of the ovary; stigmata 2, anterior, approximate, touching one another in the middle; rostellum rigid, more or less cartilaginous, linear-lanceolate to subulate, sharply pointed. Anther ovate-lanceolate, acute, umbonate; pollinia clavate with a large, narrowly oblong viscidium. Ovary fusiform, sessile.

Terrestrial, large plants with fasciculate, fleshy, fusiform roots. Leaves basal, rosulate, distinctly petiolate. Scape erect, vaginate, terminated by a short, subcorymbose, cernuous, subdense spike. Flowers conspicuous, brightly colored.

TYPE: *Spiranthes corymbosa* Krzl.

Four species native to higher elevations of Central and South America.

Index to Species

Coccineorchis bracteosa (A. & S.) Garay, comb. nov.
Basionym: Stenorrhynchus bracteosus A. & S., Sched.Orch. 8: 6, 1925.
cernua (Lindl.) Garay
corymbosa (Krzl.) Schltr.= Coccineorchis cernua (Lindl.) Garay
Coccineorchis navarrensis (Ames) Garay, comb. nov.
Basionym: Stenorrhynchus navarrensis Ames, Sched.Orch. 9: 13, 1925.
Coccineorchis Standleyi (Ames) Garay, comb. nov.
Basionym: Stenorrhynchus Standleyi Ames, Sched.Orch. 9: 14, 1925.

Cogniauxiocharis (Schltr.) Hoehne
euphlebius (Oliver ex Rchb.f.) Hoehne = Pteroglossa euphlebia (Rchb.f.) Garay
Glazioviana (Cogn.) Hoehne = Pteroglossa Glazioviana (Cogn.) Garay

Collea Lindl.
adnata Lindl. = Pelexia adnata (Sw.) Spreng.
calcarata Lindl. = Eltroplectris calcarata (Sw.) Garay & Sweet

Cotylolabium Garay, gen. nov.

Etymology: *Kotyla* = cup-shaped cavity and *labios* = lip, in reference to the hypochile of the lip.

Sepala similia, libera, subparallela. Petala cum sepalo postico conniventia, cucullam formantia. Labellum cuneato-unguiculatum, bipartitum: hypochilium cupulatum, epichilium conduplicatum, apice recurvo. Columna elongata, gracilis, basi obliqua, apoda, ungue labelli confluentia; stigmata 2, valde approximata; rostellum rigidum, plus minusve cartilagineum, aciculare, acuminatissimum. Anthera ovato-lanceolata, acuta, umbonata; pollinia clavata, viscidio anguste oblongo. Ovarium cylindraceum, sessile, leviter tortum.

Herbae terrestres, foliosae; radicibus fasciculatis, carnosis. Folia caulina, pauca. Inflorescentia terminalis, pauciflora, rhachidi spiraliter torta. Flores satis magnae, speciosae.

Sepals similar, free, subparallel. Petals with dorsal sepal connivent to form a hood over the column. Lip cuneate-unguiculate, segmented: hypochile cup-shaped, epichile conduplicate, recurved at apex. Column elongate, slender with a short oblique base, confluent with claw of lip, completely footless; stigmata 2, anterior tightly approximate; rostellum rigid, more or less cartilaginous, acicular, sharp-pointed. Anther ovate-lanceolate, acute, umbonate; pollinia clavate with narrowly oblong viscidium. Ovary cylindric, sessile, slightly twisted.

Terrestrial, leafy plants with fasiculate, fleshy roots. Leaves few, cauline. Inflorescence terminal, few-flowered with spirally twisted rachis. Flowers large, showy.

TYPE: *Stenorrhynchus Lutzii* Pabst

One species native to Brazil.

Index to species

Cotylolabium Lutzii (Pabst) Garay, comb. nov.
Basionym: Stenorrhynchus Lutzii Pabst in Rev.Bras. Biol. 15: 194, 1955.

Cranichis Sw.
thysanochila Robins. & Greenm. = Pseudocranichis thysanochila (Robins. & Greenm.) Garay

Cybebus Garay in Bot. Mus. Leafl. 26: 15, 1978.

Etymology: *Kybebos* = stooping with head bent, in reference to the rectangularly bent flowers.

Sepals similar, divaricate, arcuately spreading, basally connate into a cylindrical tube which is rectangularly attached to ovary; dorsal sepal partially adnate to back of column. Petals tightly connivent with dorsal sepal, forming a hood over column. Lip horizontal, navicular, auriculate-sagittate at base. Column rectangularly bent, expanded upwards, basally extended into a long, arcuate foot; stigmata 2, tightly approximate to almost confluent; rostellum acicular in center of deeply bilobed, blunt plate. Anther umbonate; pollinia clavate with large, elliptic viscidium in between large rostellar lobes. Ovary cylindric to fusiform, sessile, twisted.

Terrestrial, large plants with thick, tuberous roots. Leaves basal, large, prominently petiolate. Scape erect, loosely vaginate, terminated by a loosely few-flowered, secund spike. Flowers large, showy.

TYPE: *Cybebus grandis* Garay

One species, so far known only from Colombia.

Index to species

grandis Garay

Cyclopogon Presl, Rel. Haenk. 1: 93, 1827.

Etymology: *Kyklos* = circle and *pogon* = tail of fire with divided ends, in reference to the (reddish in dry condition) sepals which emerge from the circular sepaline tube resembling tails of fire with divided ends.

Sepals similar, basally connate into a cylindric tube which is perpendicular on top of ovary, free above with spreading segments. Petals connivent with dorsal sepal, at base for a short

distance adnate to sides of column. Lip broadly unguiculate, sagittate-auriculate, the claw free from sepaline tube. Column free, elongate, slender, cylindric, pubescent in front, basally produced into a short, oblique base; stigmata 2, anterior, approximate; rostellum elongate, oblong-linear, truncate or obscurely excised. Anther in the descending clinandrium erect, umbonate, 2-celled. Ovary cylindric, sessile.

Terrestrial plants with fleshy, fasciculate, villose roots. Leaves basal, rosulate, prominently petiolate. Scape slender, several-sheathed, spicate above. Flowers small, membranaceous.

TYPE: *Cyclopogon ovalifolium* Presl

One species native to the Andes of Colombia, Ecuador and Peru.

Index to species

albopunctata Barb.Rodr. = Mesadenella cuspidata (Lindl.) Garay
alexandrae (Krzl.) Schltr. = Beadlea alexandrae (Krzl.) Garay
alpestris Barb.Rodr. = Beadlea congesta (Vell.) Garay
amabilis (Ames) J. Acuña = Hapalorchis lineatus (Lindl.) Schltr.
aphyllus Schltr. = Pelexia goyazensis (Cogn.) Garay
apricus (Lindl.) Schltr. = Beadlea aprica (Lindl.) Garay
argyrifolius Barb.Rodr. = Beadlea argyrifolia (Barb.Rodr.) Garay
argyrotaenius Schltr. = Beadlea argyrotaenia (Schltr.) Garay
atroviridis Barb.Rodr. = Mesadenella atroviridis (Barb.Rodr.) Garay
Bangii (Rolfe) Schltr. = Odontorrhynchus chlorops (Rchb.f.) Garay
bicolor (Ker-Gawl.) Schltr.= Beadlea bicolor (Ker-Gawl.) Garay
bifidus (Ridl.) Schltr. = Helonoma bifida (Ridl.) Garay
Bradei Schltr. = Beadlea variegata (Barb.Rodr.) Garay
calophyllus Barb.Rodr. = Beadlea calophylla (Barb.Rodr.) Garay
candidus (Krzl.) Pabst = Hapalorchis candidus (Krzl.) Schltr.
casanaënsis Schltr. ex Mansf. = Beadlea casanaënsis (Schltr. ex Mansf.) Garay
cearensis Barb.Rodr. = Beadlea cearensis (Barb.Rodr.) Garay
chloroleucus (Barb.Rodr.) Schltr. = Stigmatosema polyaden (Vell.) Garay
congestus (Vell.) Hoehne = Beadlea congesta (Vell.) Garay
cranichoides (Griseb.) Schltr. 1920 = Beadlea cranichoides (Griseb.) Small
cranichoides Schltr. 1921 = Beadlea peruviana (Presl) Garay
cuspidatus (Lindl.) Schltr. = Mesadenella cuspidata (Lindl.) Garay
densiflorus Schltr. = Beadlea Lindleyana (Link, Kl. & Otto) Garay & Dunsterv.
diversifolius (Cogn.) Schltr. = Beadlea diversifolia (Cogn.) Garay
Doeringii Schltr. ex Hoehne, nomen = Beadlea variegata (Barb.Rodr.) Garay

Dusenii Schltr. = Beadlea Dusenii (Schltr.) Garay
Dutraei Schltr. = Beadlea Dutraei (Schltr.) Garay
elatus (Sw.) Schltr. = Beadlea elata (Sw.) Small
eldorado (Linden & Rchb.f.) Schltr. = Beadlea eldorado (Linden & Rchb.f.) Garay
elegans Hoehne = Beadlea elegans (Hoehne) Garay
Eugenii (Rchb.f. & Warm.) Schltr. = Beadlea Eugenii (Rchb.f. & Warm.) Garay
goodyeroides Schltr. = Beadlea goodyeroides (Schltr.) Garay
goyazensis (Cogn.) Schltr. = Pelexia goyazensis (Cogn.) Garay
gracilis Schltr. = Beadlea gracilis (Schltr.) Garay
graciliscapus Schltr. = Beadlea graciliscapa (Schltr.) Garay
Hatschbachii Schltr. = Beadlea Hatschbachii (Schltr.) Garay
icmadophilus (Barb.Rodr.) Schltr. = Spiranthes icmadophila Barb. Rodr.
iguapensis Schltr. = Beadlea iguapensis (Schltr.) Garay
inaequilaterus (Poepp. & Endl.) Schltr. = Beadlea inaequilatera (Poepp. & Endl.) Garay
itatiaiensis (Krzl.) Hoehne = Beadlea itatiaiensis (Krzl.) Garay
Langei Schltr. = Beadlea congesta (Vell.) Garay
laxiflorus Ekman & Mansf. = Beadlea laxiflora (Ekman & Mansf.) Garay
lineatus (Lindl.) Pabst = Hapalorchis lineata (Lindl.) Schltr.
Lindleyanus (Link, Kl. & Otto) Schltr. = Beadlea Lindleyana (Link, Kl. & Otto) Garay & Dunsterv.
longibracteatus (Barb.Rodr.) Schltr. = Beadlea longibracteata (Barb.Rodr.) Garay
luteo-albus (Rich. & Gal.) Schltr. = Beadlea luteo-alba (Rich. & Gal.) Garay
macer Schltr. = Beadlea peruviana (Presl) Garay
Maderoi Schltr. = Beadlea peruviana (Presl) Garay
micranthus (Barb.Rodr.) Schltr. = Hapalorchis micrantha (Barb.Rodr.) Hoehne
Millei (Schltr.) Schltr. = Beadlea Millei (Schltr.) Garay
minutiflorus (Rchb.f.) Schltr. = Beadlea peruviana (Presl) Garay
miradorensis Schltr. = Beadlea miradorensis (Schltr.) Garay & Dunsterv.
monophyllus (Lindl.) Schltr. = Cranichis diplhylla Sw.
moyobambae Schltr. = Beadlea inaequilatera (Poepp. & Endl.) Garay
multiflorus Schltr. = Beadlea multiflora (Schltr.) Garay
nigricans (Schltr.) Schltr. = Beadlea cranichoides (Griseb.) Small
nutantiflorus (Schltr.) Schltr. = Microthelys nutantiflora (Schltr.) Garay
oliganthus (Hoehne) Hoehne & Schltr. = Beadlea oligantha (Hoehne) Garay
olivaceus (Rolfe) Schltr. = Beadlea olivacea (Rolfe) Garay
ovalifolium Presl
paludosus (Cogn.) Schltr. = Beadlea aprica (Lindl.) Garay
Pamii (Braid) Mansf. & Herter = Beadlea Lindleyana (Link, Kl. & Otto) Garay & Dunsterv.
pauciflorus (Porto & Brade) Pabst = Hapalorchis pauciflora Porto & Brade
paulensis Schltr. = Beadlea itatiaiensis (Krzl.) Garay
peruvianus (Presl) Schltr. = Beadlea peruviana (Presl) Garay
plantagineus (Lindl.) Schltr. = Beadlea plantaginea Garay
platyunguis Schltr. = Beadlea aprica (Lindl.) Garay

Prasophyllum (Rchb.f.) Schltr. = Beadlea Prasophyllum (Rchb.f.) Hamer & Garay
procera Regnell ex Barb.Rodr. = Sauroglossum elatum Lindl.
pubescens Barb.Rodr. ex Hoehne = Beadlea bicolor (Ker-Gawl.) Garay
Rimbachii Schltr. = Beadlea Rimbachii (Schltr.) Garay
rotundifolius (Cogn.) Schltr. = Discyphus scopulariae (Rchb.f.) Schltr.
saccatus (Rich. & Gal.) Schltr. = Beadlea saccata (Rich. & Gal.) Garay
saxicolus Schltr. = Beadlea congesta (Vell.) Garay
spiranthoides Schltr. = Beadlea peruviana (Presl) Garay
stenoglossus Pabst = Hapalorchis lineatus (Lindl.) Schltr.
stictophyllus Schltr. = Beadlea olivacea (Rolfe) Garay
subalpestris Schltr. = Beadlea subalpestris (Schltr.) Garay
taquaremboënsis (Barb.Rodr.) Schltr. = Beadlea taquaremboënsis (Barb. Rodr.) Garay
trifasciatus Schltr. = Beadlea trifasciata (Schltr.) Garay
trilineatus Barb.Rodr. = Beadlea longibracteata (Barb.Rodr.) Garay
truncatus (Lindl.) Schltr. = Beadlea truncata (Lindl.) Garay
Tuerckheimii (Schltr.) Schltr. = Schiedeella Llaveana (Lindl.) Schltr.
variegatus Barb.Rodr. = Beadlea variegata (Barb.Rodr.) Garay
venustus (Barb.Rodr.) Schltr. = Beadlea venusta (Barb.Rodr.) Garay
violaceus (Rich. & Gal.) Schltr. = Schiedeella violacea (Rich. & Gal.) Garay
vittatus Dutra ex Pabst = Beadlea vittata (Dutra ex Pabst) Garay
Warmingii (Rchb.f.) Schltr. = Beadlea Warmingii (Rchb.f.) Garay

Deiregyne Schltr. in Beih. Bot. Centralbl. 37(2): 426, 1920.

Etymology: *Deire* = neck and *gyne* = pistil, woman, in reference to the position of the sepals which sit perpendicularly on top of ovary as if it were a neck-like extension.

Sepals subsimilar, connivent with spreading apices; dorsal sepal partially adnate to column; lateral sepals decurrent on column-foot, together form a gibbous nectary. Petals agglutinate with dorsal sepal, sinuous, more or less decurrent at base. Lip arcuate, conduplicate at base with more or less thickened margins; margins of blade in middle agglutinate with sides of column, apex recurved. Column arcuate, partially adnate to dorsal sepal, basally with a decurrent, somewhat incurved foot, more or less sulcate in front; stigmata 2, confluent bilobed at apex; rostellum soft, laminar, longer than wide, from a broad base variously triangular, obtuse to subacuminate. Anther ovate, cucullate to umbonate, acute or obtuse; pollinia clavate with a small, round viscidium. Ovary more or less cylindrical to fusiform, sometimes twisted.

Plants variable, all faculatative geophytes, commonly leafless during anthesis. Roots fasciculate, fleshy, tuberous. Leaves, when present, either basal or cauline, with a cuneate base. Stem erect, slender to robust, vaginate, terminated by a few- to many-flowered spike; sheath chartaceous, diaphanous. Flowers small to medium.

LECTOTYPE: *Spiranthes chloreaeformis* Rich. & Gal., *in hoc loco.*

14 species native to Mexico and Guatemala.

Index to species

Deiregyne albovaginata (C. Schweinf.) Garay, comb. nov.
Basionym: Spiranthes albovaginata C. Schweinf. in Bot. Mus. Leafl. 4: 103, 1937

Deiregyne chartacea (L.O.Wms.) Garay, comb. nov.
Basionym: Spiranthes chartacea L.O.Wms. in Bot. Mus. Leaf. 12: 226, 1946

chloreaeformis (Rich. & Gal.) Schltr. = Deiregyne diaphana (Lindl.) Garay

confusa Garay

Deiregyne dendroneura (Sheviak & Bye) Garay, comb. nov.
Basionym: Spiranthes dendroneura Sheviak & Bye in Brittonia 32: 368, 1980

Deiregyne diaphana (Lindl.) Garay, comb. nov.
Basionym: Spiranthes diaphana Lindl. in Bot. Reg. 30: Misc. 12, 1844

Deiregyne durangensis (A. & S.) Garay, comb. nov.
Basionym: Spiranthes durangensis A. & S. in Bot. Mus. Leafl. 3: 128, 1935

Deiregyne eriophora (Robins. & Greenm.) Garay, comb. nov.
Basionym: Spiranthes eriophora Robins. & Greenm. in Amer. Journ. Sci. 50: 165, 1895

Deiregyne falcata (L.O.Wms.) Garay, comb. nov.
Basionym: Spiranthes falcata L.O.Wms. in Bot. Mus. Leafl. 12: 228, 1946

hemichrea (Lindl.) Schltr. = Aulosepalum hemichrea (Lindl.) Garay

hondurensis (Schltr.) Schltr. = Gularia trilineata (Lindl.) Garay

Deiregyne obtecta (C. Schweinf.) Garay, comb. nov.
Basionym: Spiranthes obtecta C. Schweinf. in Bot. Mus. Leafl. 4: 106, 1937

obtusa (Schltr.) Schltr. = Aulosepalum Nelsonii (Greenm.) Garay

pandurata Garay

Deiregyne pseudopyramidalis (L.O.Wms.) Garay, comb. nov.
Basionym: Spiranthes pseudopyramidalis L.O.Wms. in Bot. Mus. Leafl. 12: 232, 1946

pulchra (Schltr.) Schltr. = Aulosepalum hemichrea (Lindl.) Garay

ramentacea (Lindl.) Schltr. = Aulosepalum ramentaceum (Lindl.) Garay

rhombilabia Garay
Deiregyne tenella (L.O.Wms.) Garay, comb. nov.
Basionym: Spiranthes tenella L.O.Wms. in Bot. Mus. Leafl. 12: 235, 1946
Thelymitra (Rchb.f.) Schltr. = Gularia trilineata (Lindl.) Garay
trilineata (Lindl.) Schltr. = Gularia trilineata (Lindl.) Garay
Deiregyne velata (Robins. & Fern.) Garay, comb. nov.
Basionym: Spiranthes velata Robins. & Fern. in Proc. Amer. Acad. Sci. 30: 122, 1894

Dichromanthus Garay, gen. nov.

Etymology: Prefix *di-* = two, *chroma* = color and *anthos* = flower, signifying the nature of the flowers.

Sepala similia, conniventia, apicibus patentibus; sepalum posticum columna dorsaliter adnatum, basi decurrenti; sepala lateralia tantum pedem columnae adnata. Petala margine interiore sepalo intermedio agglutinata, sinuosa, basi decurrentia. Labellum sessile, basi canaliculato-conduplicatum, marginibus calloso-incrassatis, naviculare, laminae margines in medio utrinque lateribus columnae agglutinatae. Columna brevis, erecta, pede decurrenti, facie puberula; stigmata 2, confluentia, apice biloba; rostellum tenue, erectum, lineari-oblongum, apice rotunda. Anthera ovato-cucullata, acuta; pollinia clavata, viscidio elongato, oblongo-lineari affixa. Ovarium subcylindrico-fusiforme, paululum tortum.

Plantae terrestres, validae, erectae, sub anthesin vulgo foliosae; radicibus fasciculatis, stipitato-fusiformibus, carnosis; foliis paucis, vaginatis, precipue caulinis in parte inferiori caulium; caulibus erectis, supra vaginato-bracteolatis, spicis conicis vel cylindraeceis, dense multifloris; floribus magnis, speciosis bicoloribus, erectis, quaquaversalis.

Sepals similar, connivent, with flared apices; dorsal sepal adnate to column dorsally and decurrent on ovary; lateral sepals adnate only to column-foot. Petals sinuous, decurrent on column-foot. Lip sessile, conduplicate-channelled at base with thickened margins, lamina navicular with the sides in middle agglutinate with column. Column rather short, erect with a decurrent foot, pubescent in front; stigmata 2, confluent, bilobed at apex; rostellum soft, erect, linear-oblong, rounded at apex.

Anther ovate-cucullate, acute; pollinia clavate with an elongate, oblong-linear viscidium. Ovary subcylindric-fusiform, somewhat twisted.

Plants terrestrial, erect, commonly leafy during flowering time. Roots fasciculate, stipitately fusiform, fleshy. Leaves several, mostly cauline on lower part of stem, vaginate. Stem erect, vaginate-bracteate above, terminating in a conical to cylindric, densely many-flowered spike. Flowers large, showy, bicolored, erect, quaquaversal.

TYPE: *Neottia cinnabarina* Llave & Lex.

One species native to Mexico and Guatemala.

Index to species

Dichromanthus cinnabarinus (Llave & Lex.) Garay, comb. nov.
Basionym: Neottia cinnabarina Llave & Lex., Nov. Veg. Desc. 2, Orch. Op. 3, 1825.

Dikylikostigma Krzl.
Preussii Krzl. = Discyphus scopulariae (Rchb.f.) Schltr.

Discyphus Schltr. in Fedde, Rep. 15: 417, 1919.
Etymology: Prefix *Di* = two and *skyphos* = cup, in reference to the nature of the stigmata, which are terminal and in dry condition form distinct cup-like cavities.
Syn.: *Dikylikostigma* Krzl. in Notizbl. Bot. Gart. Berlin 7: 321, 1919.
Type: *Dikylikostigma Preussii* Krzl.

Sepals subsimilar, ringent; dorsal sepal deeply concave, basally fuse with lateral sepals for a short distance; lateral sepals connate at base, long-decurrent on column-foot, together form an internal, cyathiform nectary. Petals somewhat sinuous, free from dorsal sepal, with a decurrent base. Lip long-clawed, the claw fully adnate to connate part of lateral sepals, fleshy sagittate at base. Column short, conduplicate-furrowed in front, basally produced in a long-decurrent, incurved foot; stigmata 2, terminal on top of truncate column, cupuliform, well separated by the frontal furrow of column; rostellum arrect, deeply bifid to

bicuspidate. Anther ovate, acute; pollinia clavate with narrowly elliptic viscidium. Ovary arcuately cylindric, twisted.

Terrestrial, small plants with fasciculate, fusiform roots. Leaf cordate, basal, horizontal on soil. Stem erect, pilose, terminated by a subdensely many-flowered spike. Flowers small, glandulose-pilose.

TYPE: *Spiranthes scopulariae* Rchb.f.

One species, native to Panama, Venezuela, Trinidad and Brazil.

Index to species

scopulariae (Rchb.f.) Schltr.

Dithyridanthus Garay, gen. nov.

Etymology: *Di-* = prefix, two, *thyridos* = small windows and *anthos* = flower, describing the two lateral openings formed by the dorsal and lateral sepals at the base of the flower.

Sepala subsimilia, conniventia, leviter arcuata, ad basin urceolatim extensa, utrinque aperturam quasi fenestram basalem formantia; sepala lateralia inter se breviter connata, ungue labelli dorsaliter adnata, et cum eo saccum didymum satis conspicuum formantia. Petala margine interiore sepalo intermedio agglutinata, linearia. Labellum carnosum, satis longe unguiculatum, ungue ad basin columnae arcuatim decurvo, sepalis lateralibus adnato et cum iis mentum prominens ostendenti; lamina labelli unguem rectangulariter inserta, conduplicata, apice recurva, basi excavato-gibbosa, margine in medio utrinque lateribus columnae modice agglutinata. Columna apici ovarii rectangulariter inserta, satis brevis, arcuata, basi obliqua sed apoda, dorsaliter sepalo intermedio adnata, facie puberula; stigmata 2, longitudinaliter elliptica, confluentia, apice biloba; rostellum satis rigidum, oblongo-lineare acuminatum, satis elongatum. Anthera ovata, umbonata, acuta; pollinia clavata, glandula lineari-oblonga affixa. Ovarium cylindricum, paululo tortum, apice arcuato-colliforme.

Plantae terrestres, elatae; radicibus fasciculatis, stipitato-fusiformibus, carnosis; foliis caulinis, sursum in vaginis transeuntibus; inflorescentia cylindrica, spicata, dense multiflora; floribus quaquaversis, in bracteas chartaceas, pulchre venosas omnino absconditis.

Sepals subsimilar, connivent, somewhat arcuate, basally enlarged like an urn, on both sides of the flower at base becoming separated and form an opening like small windows; lateral sepals connate at base and adnate dorsally to claw of lip, together they form a rather prominent didymous sac. Petals linear, with the interior margins agglutinate with dorsal sepal. Lip fleshy, rather long clawed; claw arcuately recurved from base of column, fused with lateral sepals, together they display a prominent mentum; blade of lip inserted rectangularly to claw, conduplicate with a recurved apex, basally excavate-gibbose, the margins in the middle somewhat agglutinate with sides of column. Column rectangularly inserted on top of ovary, rather short, arcuate, with an oblique base, footless!, dorsally adnate to dorsal sepal, pubescent in front; stigmata 2, longitudinally elliptic, confluent, with a bilobed apex; rostellum rather rigid, oblong-linear, acuminate, quite elongate. Anther ovate, umbonate, acute; pollinia clavate, affixed to linear-oblong viscidium. Ovary cylindric, somewhat twisted, with an arcuate neck-like extension.

Plants terrestrial, rather robust, tall, with fasciculate, stipitate-fusiform roots; leaves cauline, becoming bract-like upwards; inflorescence cylindric, spicate, densely many-flowered; flowers allsided, completely hidden in large, rather attractively veined, chartaceous bracts.

TYPE: *Spiranthes densiflora* C. Schweinf.

One species native to Mexico

Index to species

Dithyridanthus densiflorus (C. Schweinf.) Garay, comb. nov.
Basionym: Spiranthes densiflora C. Schweinf. in Bot. Mus. Leafl. 4: 104. 1937.

Eltroplectris Raf., Fl. Tellur. 2:51, 1837.

Etymology: *Eltro*, a corrupt form of *eleutheros* = free and *plectron* = spur, in reference to the spur-like process formed by the lateral sepals with the free-projecting column-foot.

Syn.: *Centrogenium* Schltr. in Beih. Bot. Centralbl. 37(2): 451, 1920.

Lectotype: *Neottia calcarata* Sw. [Correa in Darwiniana 11: 81, 1955]

Sepals free, unequal in size, somewhat spreading; lateral sepals longer than dorsal sepal, decurrent on column-foot and with free part of column-foot form a pendulous, spur-like process. Petals agglutinate with dorsal sepal, basally decurrent on column. Lip membranaceous, with a distinct claw, arcuately recurved, towards base with marginal thickenings, somewhat shorter than sepals. Column slender, rather short, erect, basally extended into a long column-foot which at first adnate to ovary then freely protruding from ovarian tissue; stigmata 2, free to approximate, but never confluent, terminal, horizontal, often appear bilobed, more or less separated from one another by terminal edge of a distinct fold running full length on face of column; rostellum rigid, more or less cartilaginous, subulate to linear, sharply pointed. Anther ovate-cucullate, persistent; pollinia clavate with an oblong viscidium. Ovary cylindric, sessile or subsessile.

Terrestrial, erect herbs with fleshy, fasciculate roots. Leaves one to several, basal, petiolate, occasionally withering during anthesis. Stem slender, erect, vaginate, terminated by a few- to many-flowered, lax raceme or spike. Flowers variable in size.

TYPE: *Neottia calcarata* Sw.

Ten species native to the American tropics and subtropics.

Index to species.

acuminata Raf. = Eltroplectris calcarata (Sw.) Garay & Sweet
calcarata (Sw.) Garay & Sweet
Cogniauxiana (Schltr.) Pabst
janeirensis (Porto & Brade) Pabst

Kuhlmanniana (Hoehne) Pabst
longicornu (Cogn.) Pabst
lurida (Correa) Pabst = Pteroglossa lurida (Correa) Garay
macrophylla (Schltr.) Pabst
pauciflora (Poepp. & Endl.) Garay
roseoalba (Rchb.f.) Hamer & Garay
Schlechterana (Porto & Brade) Pabst
Eltroplectris Travassosii (Rolfe) Garay, comb. nov.
Basionym: Pelexia Travassosii Rolfe in Gard. Chron. ser. 3, 11: 330, 1892.
triloba (Lindl.) Pabst

Epidendrum L.
Aristotelia Raeusch. = Spiranthes sinensis (Pers.) Ames

Epipactis Zinn
diuretica (Willd.) Stokes = Brachystele unilateralis (Poir.) Schltr.
spiralis (L.) Crantz = Spiranthes spiralis (L.) Chevall.

Erythrodes Bl.
pauciflora (Poepp. & Endl.) Ames = Eltroplectris pauciflora (Poepp. & Endl.) Garay

Eurystyles Wawra in Oesterr. Bot. Zeitschr. 13: 223, 1863.
Etymology: *Eurys* = broad and *stylis* = pillar, column, describing the shape of the column which in the original material unfortunately was deformed.
Syn.: *Trachelosiphon* Schltr. in Beih. Bot. Centralbl. 37(2): 423, 1920.
Lectotype: *Spiranthes actinosophila* Barb.Rodr. [Acuña in Bol. Tec. 60: 43, 1939]
Pseudoëurystyles Hoehne in Arqu. Est. S. Paulo, n.s.form.m. 1: 129, 1944.
Lectotype: *Stenoptera Lorenzii* Cogn. [Angely, Fl. Analit. S. Paulo 6: 1273, 1973]
Sepals dissimilar, basally connate into a tube, always cristate-carinate along midvein externally; dorsal sepal with a decurrent base, partially adnate to column; lateral sepals connate at base forming a ventricose to didymous sac to which the claw of lip is adnate internally. Petals internally agglutinate with dorsal sepal, decurrent at base. Lip canaliculate, parallel with column, broadly unguiculate, saggitate-auriculate at base, claw fused with inflated part of lateral sepals, together they form an internal nectary. Column slender, elongate, with a long, decurrent,

incurved foot; stigmata 2, approximate to confluent; rostellum laminar, erect, membranaceous, acute to obtuse. Anther ovate-cucullate, acute; pollinia clavate with a small, roundish viscidium. Ovary sessile, very slightly twisted, sometimes colliferous at apex.

Plants small to miniature, facultative epiphytes, growing on branches of trees, with slender, fleshy roots. Leaves basal, rosulate, with ciliate to hairy blades. Scape short, erect to arcuately pendent, few-sheathed, terminated by a densely compact, capitate spike. Flowers small to minute, mostly hidden by large, ciliolate bracts.

TYPE: *Eurystyles cotyledon* Wawra

13 species native to regions of New World tropics.

Index to species

actinosophila (Barb.Rodr.) Schltr.
alticola Dod = Eurystyles auriculata Schltr.
ananassocomus (Rchb.f.) Schltr.
auriculata Schltr.
borealis A.H. Heller
Cogniauxii (Krzl.) Schltr.
colombiana (Schltr.) Schltr.
Cotyledon Wawra
cristata (Schltr.) Schltr.
domingensis Dod = Eurystyles Gardneri (Lindl. ex Gardn.) Garay
Gardneri (Lindl. ex Gardn.) Garay
Eurystyles Guentherana (Krzl.) Garay, comb. nov.
Basionym: Stenoptera Guentherana Krzl. in Fedde, Rep. 25: 19, 1928.
Lorenzii (Cogn.) Schltr.
paranaënsis (Schltr.) Schltr.
Standleyi Ames

Funckiella Schltr. in Beih. Bot. Centralb. 37(2): 430, 1920, orthogr. correct.

Etymology: In honor of Nicolas Funck (1816 1896), a Belgian explorer and avid orchid collector who in commercial circles was known by the affectionate name, "l'Oncle Funck".

Sepals dissimilar, horizontal, subparallel to ringent; dorsal sepal partially adnate to back of column; lateral sepals oblique

at base, somewhat enlarged, together with gibbose-saccate base of lip form an obtuse mentum. Petals agglutinate with dorsal sepal, at most oblique at base. Lip conduplicate, arcuate, lower half rather fleshy, excavate-gibbose at base with marginal thickenings and continuous with the incurved column-foot. Column rather slender, horizontal to suberect, with a short, incurved foot; stigmata 2, confluent; rostellum filiform, thin, pliable. Anther ovate-cordate, acute; pollinia clavate with a linear-oblong viscidium. Ovary cylindric, barely twisted.

Terrestrial, large plants with fasciculate, fleshy roots or tubers. Leaves, when present, basal, few. Scape erect, vaginate, terminated by a loosely few-flowered, commonly secund spike. Flowers large, horizontal.

TYPE: *Spiranthes hyemalis* Rich. & Gal.

Three species native to Mexico and Guatemala.

Index to species

Funckiella congestiflora (L.O. Wms.) Garay, comb. nov.
Basionym: Spiranthes congestiflora L.O. Wms. in Bot. Mus. Leafl. 12: 227, 1946.
hyemalis (Rich. & Gal.) Schltr.
Funckiella stolonifera (Ames & Correll) Garay, comb. nov.
Basionym: Spiranthes stolonifera Ames & Correll in Bot. Mus. Leafl. 10: 63, 1942.

Galeottiella Schltr. in Beih. Bot. Centralbl. 37 (2): 360, 1920.

Etymology: In honor of Henri-Guillaume Galeotti (1814 1858) who collected extensively in Mexico, especially orchids, between December 1835 and June 1840.

Sepals dissimilar, erect; dorsal sepal deeply concave, halfway adnate to back of column; lateral sepals long-decurrent on column-foot, basally somewhat connate, together with incurved tip of column-foot form an internal nectary, apices spreadingly revolute. Petals narrow, interior margins agglutinate with dorsal sepal, anterior margin thickened, ciliolate. Lip spathulate-cochleate, very fleshy with thin margins, sessile, parallel with column, somewhat gibbose at base. Column slender with a rectangularly bent apex and an incurved foot; stigmata 2, approxi-

mate; rostellum distinctly bilobed, with broad, obtuse lobules. Anther ovate-quadrate, blunt; pollinia clavate with a small, elliptic, fleshy viscidium which tightly fits between the rostellar lobes. Ovary cylindric, sessile, somewhat twisted.

Terrestrial, erect plants with fasciculate, fleshy roots. Leaves cauline, decreasing in size upwards. Stem erect, terminated by loosely many-flowered, allsided or subsecund spike. Flowers small.

TYPE: *Spiranthes sarcoglossa* Rich. & Gal.

One species native to Mexico and Guatemala.

Index to species

sarcoglossa (Rich. & Gal.) Schltr.

Gamosepalum Schltr.
tenuiflorum (Greenm.) Schltr. = Aulosepalum tenuiflorum (Greenm.) Garay

Goodyera R. Br.
erythrosticta Griseb. = Pseudogoodyera Wrightii (Rchb.f.) Schltr.
guayanensis Lindl. = Brachystele guayanensis (Lindl.) Schltr.
Wrightii Rchb.f. = Pseudogoodyera Wrightii (Rchb.f.) Schltr.

Gularia Garay, gen. nov.

Etymology: *Gula* = gullet, throat, in reference to the appearance of the tubular flower.

Sepala dissimilia, basin inter se connata, tubum formantia; sepalum posticum columnae dorsaliter adnatum, concavum; sepala lateralia decurrentia, cum pede columnae nectarium oblique cylindricum formantia, apicibus paululo divergentibus. Petala sepalo postico conniventia et cum eo margine interiore agglutinata, basi decurrentia. Labellum longe unguiculatum, ungue basi sepalorum lateralium adnatum, deinde auriculatum vel sagittatum, apice carnosum, paululo recurvum, in medio laminae margines lateribus columnae arcte agglutinatum. Columna elongata, gracilis, apicem versus sensim dilatata, facie puberula, basi in pedem longam, decurrentem producta; stigmata 2, confluentia, apice obscure biloba; rostellum erectum, tenue, triangulare, acutum. Anthera ovata, cucullata, acuta; pollinia clavata, viscidio ovato. Ovarium cylindricum, tortum.

Plantae terrestres, spithameae, sub anthesin aphyllae; radicibus fasciculatis, tuberoso-fusiformibus; foliis ut videtur basilaribus; caulibus erectis, chartaceo-vaginatis, supra laxe spicatis, paucifloris; floribus erectis, quaquaversis.

Sepals dissimilar, basally connate into a tube; dorsal sepal concave, adnate to back of column; lateral sepals decurrent on column-foot, and together form an obliquely cylindric nectary, the apices somewhat divergent. Petals connivent with dorsal sepal, the inner margins agglutinate with it, decurrent at base. Lip with a long claw which is adnate to the connate base of lateral sepals, blade auriculate or sagittate at base, fleshy at the slightly recurved apex, the margins in the middle agglutinate with sides of column. Column elongate, slender, somewhat expanding upwards, with a puberulent front, basally produced in a long, decurrent foot; stigmata 2, confluent, obscurely bilobed at apex; rostellum erect, pliable, triangular, acute. Anther ovate, cucullate, acute; pollinia clavate with an ovate viscidium. Ovary cylindric, twisted.

Terrestrial, small plant, aphyllous during anthesis. Roots fasciculate, tuberous-fusiform; Leaves absent during flowering time, appear to be rosulate from remnants. Stem erect, slender, heavily chartaceous-vaginate, terminated by a loosely few-flowered spike. Flowers of medium size, allsided, erect on top of ovary.

TYPE: *Spiranthes trilineata* Lindl.

Two species native to Mexico and Guatemala.

Index to species

Gularia crenulata (L.O. Wms.) Garay, comb. et stat. nov.
Basionym: Spiranthes trilineata var. crenulata L.O. Wms. in Bot. Mus. Leafl. 12:36, 1946.

Gularia trilineata (Lindl.) Garay, comb. nov.
Basionym: Spiranthes trilineata Lindl. in Benth., Pl. Hartweg. 94, 1842.

Gyrostachys Pers. ex Bl.
acutata (Rchb.f. & Warm.) O. Ktze. = Sarcoglottis acutata (Rchb.f. & Warm.) Garay
aestivalis (Poir.) Dumort. = Spiranthes aestivalis (Poir.) L.C. Rich.
aguacatensis (Rchb.f.) O. Ktze. = Brachystele guayanensis (Lindl.) Schltr.

amoena (Bieb.) Bl. = Spiranthes amoena (Bieb.) Spreng.
aphylla (Hook.) O. Ktze. = Sacoila lanceolata (Aubl.) Garay
apiculata (Lindl.) O. Ktze. = Spiranthes torta (Thunb.) Garay & Sweet
aprica (Lindl.) O. Ktze. = Beadlea aprica (Lindl.) Garay
Arrabidae (Rchb.f.) O. Ktze. = Pelexia Arrabidae (Rchb.f.) Garay
assurgens (Rchb.f.) O. Ktze. = Sarcoglottis assurgens (Rchb.f.) Schltr.
aurantiaca (Llave & Lex.) O. Ktze. = Stenorrhynchos aurantiacum (Llave & Lex.) Lindl.
australis (R. Br.) Bl. = Spiranthes sinensis (Pers.) Ames
auctumnalis Bl. = Spiranthes spiralis (L.) Chevall.
autumnalis (Balb.) Dumort. = Spiranthes spiralis (L.) Chevall.
balanophorostachya (Rchb.f.) O. Ktze. = Skeptrostachys balanophorostachya (Rchb.f. & Warm.) Garay
Beckii (Lindl.) Stone = Spiranthes lacera (Raf.) Raf.
bicolor (Ker-Gawl.) O. Ktze. = Beadlea bicolor (Ker-Gawl.) Garay
bonariensis (Lindl.) O. Ktze. = Pelexia bonariensis (Lindl.) Schltr.
bracteosa (Lindl.) O. Ktze. = Brachystele bracteosa (Lindl.) Schltr.
brevifolia (Chapm.) O. Ktze. = Spiranthes longilabris Lindl.
brevilabris (Lindl.) O. Ktze. = Spiranthes brevilabris Lindl.
camporum (Lindl.) O. Ktze. = Brachystele camporum (Lindl.) Schltr.
cernua (L.) O. Ktze. = Spiranthes cernua (L.) L.C. Rich.
chilensis (A. Rich.) O. Ktze. = Odontorrhynchus chilensis (A. Rich.) Garay
chloreaeformis (Rich. & Gal.) O. Ktze. = Deiregyne diaphana (Lindl.) Garay
chlorops (Rchb.f.) O. Ktze. = Odontorrhynchus chlorops (Rchb.f.) Garay
cinnabarina (Llave & Lex.) O. Ktze. = Dichromanthus cinnabarinus (Llave & Lex.) Garay
Cogniauxii O. Ktze. = Pelexia comosa (Cogn.) Schltr.
comosa (Rchb.f.) O. Ktze. = Beadlea comosa (Rchb.f.) Hamer & Garay
congesta (Lindl.) O. Ktze. = Spiranthes congesta Lindl.
constricta Small = Spiranthes odorata (Nutt.) Lindl.
costaricensis (Rchb.f.) O. Ktze. = Beloglottis costaricensis (Rchb.f.) Schltr.
cuculligera (Rchb.f. & Warm.) O. Ktze. = Pelexia cuculligera (Rchb.f. & Warm.) Schltr.
cuspidata (Lindl.) O. Ktze. = Mesadenella cuspidata (Lindl.) Garay
dilatata (Lindl.) O. Ktze. = Brachystele dilatata (Lindl.) Schltr.
ensifolia (Rchb.f.) O. Ktze. = Spiranthes vernalis Engelm. & Gray
Eugenii (Rchb.f. & Warm.) O. Ktze. = Beadlea Eugenii (Rchb.f. & Warm.) Garay
Funckiana (Rich. & Gal.) O. Ktze. = Pelexia Funckiana (Rich. & Gal.) Schltr.
gemmipara (J.E.Sm.) O. Ktze. = Spiranthes Romanzoffiana Cham.
gracilis (Bigel.) O. Ktze. = Spiranthes lacera (Raf.) Raf.
graminea (Lindl.) O. Ktze. = Spiranthes graminea Lindl.
grandiflora (Lindl.) O. Ktze. = Sarcoglottis grandiflora (Lindl.) Kl.
Grayi (Ames) Britton = Spiranthes tuberosa Raf.
gutturosa (Rchb.f.) O. Ktze. = Pelexia gutturosa (Rchb.f.) Garay
Haenkeana O. Ktze.= Beadlea peruviana (Presl) Garay
hemichrea (Lindl.) O. Ktze. = Aulosepalum hemichrea (Lindl.) Garay
hirta (Lindl.) O. Ktze. = Pelexia hirta (Lindl.) Schltr.
homalogastra (Rchb.f. & Warm.) O. Ktze. = Sarcoglottis homalogastra (Rchb.f. & Warm.) Schltr.

Hostmannii (Rchb.f.) O. Ktze. = Brachystele guayanensis (Lindl.) Schltr.
inaequilatera (Poepp. & Endl.) O. Ktze. = Beadlea inaequilatera (Poepp. & Endl.) Garay
laciniata Small = Spiranthes laciniata (Small) Ames
lanceolata (Aubl.) O. Ktze. = Sacoila lanceolata (Aubl.) Garay
latifolia (Torr.) O. Ktze. = Spiranthes lucida (H.H.Eaton) Ames
linearis Rydb. = Spiranthes vernalis Engelm. & Gray
lineata (Lindl.) O. Ktze. = Hapalorchis lineatus (Lindl.) Schltr.
Lindleyana (Link, Kl., & Otto) O. Ktze. = Beadlea Lindleyana (Link, Kl. & Otto) Garay & Dunsterv.
longilabris (Lindl.) O. Ktze. = Spiranthes longilabris Lindl.
longipetiolata (Rchb.f.) O. Ktze. = Pelexia laxa (Poepp. & Endl.) Lindl.
lupulina (Lindl.) O. Ktze. = Stenorrhynchos aurantiacum (Llave & Lex.) Lindl.
macrantha (Rchb.f.) O. Ktze. = Pteroglossa macrantha (Rchb.f.) Schltr.
macrostachya (Poepp. & Endl.) O. Ktze. = Stenoptera macrostachya (Poepp. & Endl.) Rchb.f.
madrensis (Rchb.f.) O. Ktze. = Stenorrhynchos michuacanum (Llave & Lex.) Lindl.
Mandonii (Rchb.f.) O. Ktze. = Pelexia Mandonii (Rchb.f.) Schltr.
michuacana (Llave & Lex.) O. Ktze. = Stenorrhynchos michuacanum (Llave & Lex.) Lindl.
minor (Jacq.) O. Ktze. = Beadlea elata (Sw.) Small
minutiflora (Rchb.f.) O. Ktze. = Beadlea peruviana (Presl) Garay
montana (Lindl.) O. Ktze. = Dichromanthus cinnabarinus (Llave & Lex.) Garay
nesophila (Rchb.f.) O. Ktze. = Basionym unknown!
neuroptera (Rchb.f. & Warm.) O. Ktze. = Sarcoglottis neuroptera (Rchb.f. & Warm.) Schltr.
novofriburgensis (Rchb.f.) O. Ktze. = Pelexia novofriburgensis (Rchb.f.) Garay
ochroleuca Rydb. = Spiranthes ochroleuca (Rydb.) Rydb.
odorata (Nutt.) O. Ktze. = Spiranthes odorata (Nutt.) Lindl.
oestrifera (Rchb.f. & Warm.) O. Ktze. = Pelexia oestrifera (Rchb.f. & Warm.) Schltr.
orchioides (Sw.) O. Ktze. = Sacoila lanceolata (Aubl.) Garay
orthosepala (Rchb.f. & Warm.) O. Ktze. = Pelexia orthosepala (Rchb.f. & Warm.) Schltr.
ovalifolia (Presl) O. Ktze. = Cyclopogon ovalifolium Presl
ovalis (Lindl.) O. Ktze. = Spiranthes ovalis Lindl.
papulosa (Lindl.) O. Ktze. = Stenorrhynchos papulosum (Llave & Lex.) Lindl.
parviflora (Chapm.) Small = Spiranthes ovalis Lindl.
pauciflora (Rchb.f.) O. Ktze. = Funckiella hyemalis (Rich. & Gal.) Schltr.
peruviana (Aubl.) O. Ktze. = Spiranthes torta (Thunb.) Garay & Sweet
picta (Anders.) O. Ktze. = Sarcoglottis acaulis (J.E.Sm.) Schltr.
plantaginea (Don) O. Ktze. = Malaxis latifolia J.E.Sm.
plantaginea (Torr.) Britt. & Br. = Spiranthes lucida (H.H. Eaton) Ames
polyantha (Rchb.f.) O. Ktze. = Mesadenus polyanthus (Rchb.f.) Schltr.

porrifolia (Lindl.) O. Ktze. = Spiranthes porrifolia Lindl.
praecox (Walt.) O. Ktze. = Spiranthes praecox (Walt.) Wats.
prasophylla (Rchb.f.) O. Ktze. = Beadlea Prasophyllum (Rchb.f.) Hamer & Garay
pterygantha (Rchb.f. & Warm.) O. Ktze. = Pelexia pterygantha (Rchb.f. & Warm.) Schltr.
pyramidalis (Lindl.) O. Ktze. = Kionophyton pyramidalis (Lindl.) Garay
ramentacea (Lindl.) O. Ktze. = Aulosepalum ramentaceum (Lindl.) Garay
Reverchonii Small = Spiranthes vernalis Engelm. & Gray
Romanzoffiana (Cham.) MacMill. = Spiranthes Romanzoffiana Cham.
rupestris (Lindl.) O. Ktze. = Skeptrostachys rupestris (Lindl.) Garay
saccata (Rich. & Gal.) O. Ktze. = Beadlea saccata (Rich. & Gal.) Garay
sagittata (Rchb.f. & Warm.) O. Ktze. = Sarcoglottis sagittata (Rchb.f. & Warm.) Schltr.
sancta (Rchb.f. & Warm.) O. Ktze. = Pelexia sancta (Rchb.f. & Warm.) Garay
sarcoglossa (Rich. & Gal.) O. Ktze. = Galeottiella sarcoglossa (Rich. & Gal.) Schltr.
Sarcoglottis O. Ktze. = Sarcoglottis acaulis (J.E.Sm.) Schltr.
sceptrodes (Rchb.f.) O. Ktze. = Sarcoglottis sceptrodes (Rchb.f.) Schltr.
Schaffneri (Rchb.f.) O. Ktze. = Pelexia Schaffneri (Rchb.f.) Schltr.
scopulariae (Rchb.f.) O. Ktze. = Discyphus scopulariae (Rchb.f.) Schltr.
simplex (A. Gray) O. Ktze. = Spiranthes tuberosa Raf.
Smithii (Rchb.f.) O. Ktze. = Pelexia Smithii (Rchb.f.) Garay
speciosa (Jacq.) O. Ktze. = Stenorrhynchos speciosum (Jacq.) L.C. Rich ex Spreng.
spiralis (L.) O. Ktze. = Spiranthes spiralis (L.) Chevall.
Stenorrhynchos O. Ktze. = Sacoila lanceolata (Aubl.) Garay
stricta Rydb. = Spiranthes Romanzoffiana Cham.
stylites (Lindl.) O. Ktze. = Spiranthes stylites Lindl.
sulfurea (Llave & Lex.) O. Ktze. = Stenorrhynchos michuacanum (Llave & Lex.) Lindl.
tenuis (Lindl.) O. Ktze. = Spiranthes tenuis Lindl.
Thelymitra (Rchb.f.) O. Ktze. = Gularia trilineata (Lindl.) Garay
trilineata (Lindl.) O. Ktze. = Gularia trilineata (Lindl.) Garay
triloba Small = Spiranthes odorata (Nutt.) Lindl.
truncata (Lindl.) O. Ktze. = Beadlea truncata (Lindl.) Garay
unilateralis (Poir.) O. Ktze. = Brachystele unilateralis (Poir.) Schltr.
vaginata (H.B.K.) O. Ktze. = Stenorrhynchos vaginatum (H.B.K.) Spreng.
vernalis (Engelm. & Gray) O. Ktze. = Spiranthes vernalis Engelm. & Gray
villosa (Poepp. & Endl.) O. Ktze. = Sarcoglottis villosa (Poepp. & Endl.) Schltr.
Warmingii (Rchb.f.) O. Ktze. = Beadlea Warmingii (Rchb.f.) Garay
Wightiana (Lindl.) O. Ktze. = Spiranthes Wightiana Lindl.
xyridifolia Small = Spiranthes vernalis Engelm. & Gray

Hapalorchis Schltr. in Fedde, Rep, Beih. 6: 30, 1919.

Etymology: *Hapalos* = delicate, soft and *orchis* = orchid, in reference to the delicate texture of the entire plant.

Sepals free, similar, parallel to subparallel, ringent; lateral sepals somewhat oblique, more or less gibbose at base, together with the base of the lip form a short, rounded mentum. Petals connivent with dorsal sepal and the interior margin firmly agglutinate to it. Lip sessile with a concave, excavate base which is often obscurely didymous, and marginally thickened without forming free calli; blade conduplicate-canaliculate with a terminal lobe. Column slender, papillose to pubescent in front, obliquely extended at base on top of ovary; stigmata 2, confluent, bilobed at apex; rostellum suberect, oblong-subtriangular to ligulate, pliable, longer than wide, excised at apex; clinandrium lobulate, infundibuliform. Anther erect, deeply concave to cucullate, with a cordate base, acuminate towards apex; pollinia clavate with an ovate to oblanceolate viscidium. Ovary sessile to subsessile.

Terrestrial, delicate plants. Roots fleshy, tuber-like, originating from distant to more or less approximate nodes. Leaves mostly congested at base, petiolate, vaginate at base. Stem ascending from a rhizomatous or subrhizomatous base, slender, terminated by a few-flowered, secund spike. Flowers delicate in texture, commonly outcrossing, rarely autogamous.

TYPE: *Hapalorchis cheirostyloides* Schltr.

9 species native to American tropics and subtropics.

Index to species

candidus (Krzl.) Schltr.
cheirostyloides Schltr.
Lindleyanus Garay
lineatus (Lindl.) Schltr.
longirostris Schltr.
micranthus (Barb. Rodr.) Hoehne
pauciflorus Porto & Brade
pumilus (C. Schweinf.) Garay
rhombiglossus Pabst = Mesadenus rhombiglossus (Pabst) Garay

tenuis (Lindl.) Schltr. = Hapalorchis lineatus (Lindl.) Schltr.
trilobata Schltr.

Helonoma Garay, gen. nov.

Etymology: *Helonomos* = living in a marsh or bog, describing the habitat of the plants.

Sepala similia, inter se satis alte connata, nectarium vel tubum amplum formantia, apicibus patentibus; sepalo postico columnae dorsaliter adnato; sepalis lateralibus obliquis, antice paululo ampliatis. Petala sepalo postico partim agglutinata, basi leviter decurrentia. Labellum longe unguiculatum, ungue tubo sepalino omnino adnato, deinde sagittatum, marginibus in medio utrinque columnae lateribus agglutinatis. Columna erecta vel suberecta, dorsaliter sepalo postico satis alte adnata, apice libera, basi in pedem brevem apici ovarii oblique producta; stigmata 2, vulgo separata, sese haud tigentia; rostellum breve, obtusum, plerumque in floribus autogamis dissolutum. Anthera ovato-lanceolata, cucullata, acuminata; pollinia lineari-clavata, viscidio parvulo, rotundo affixa. Ovarium fusiforme, sessile, haud tortum.

Plantae terrestres, vulgo autogamae, graciles, spithameae vel ultra; radicibus cylindraceis, carnosis, pubescentibus; foliis basalibus, petiolatis; caulibus e rhizomate brevi decumbenti erectis vel suberectis, remote pauci-bracteatis, apice laxe denseque spicatis; floribus parvulis.

Sepals similar, basal half connate into a more or less broadly tubular nectary, apical half with spreading segments; dorsal sepal adnate to back of column; lateral sepals somewhat oblique and extended basally. Petals for the most part, especially the inner margins agglutinate with dorsal sepal, basally somewhat decurrent. Lip with a long claw which is fully adnate to fused part of lateral sepals, then expanded into a sagittate blade, the sides of which agglutinate with column. Column erect to suberect, to base of clinandrium adnate to dorsal sepal, basally produced in a short, oblique foot on top of ovary, in front with a longitudinal groove; stigmata 2, commonly free with sides hardly touching one another; rostellum short, triangular, obtuse, mostly ruptured or dissolved in autogamous flowers. Anther ovate-lanceolate, cucullate, acuminate at apex; pollinia linear-

clavate, with a small, round viscidium. Ovary fusiform, sessile, hardly twisted.

Terrestrial, slender plants, commonly autogamous. Roots cylindric, slender, fleshy, pubescent. Leaves basal, petiolate. Stem from a decumbent, short rhizome, erect or suberect, remotely few-bracteate, terminated by a loosely to densely flowered spike. Flowers small.

TYPE: *Manniella americana* C. Schweinf. & Garay

Two species native to South America, in the Venezuela-Guayana Massif.

Index to species

Helonoma americana (C. Schweinf. & Garay) Garay, comb. nov.
Basionym: Manniella americana C. Schweinf. & Garay in Bot. Mus. Leafl. 20:5, 1962.
Helonoma bifida (Ridl.) Garay, comb. nov.
Basionym: Spiranthes bifida Ridl. in Thimeri 5: 105, 1886.

Ibidium Salisb. ex Small
Beckii (Lindl.) House = Spiranthes lacera (Raf.) Raf.
cernuum (L.) House = Spiranthes cernua (L.) L.C. Rich.
coloratum (N.E.Br.) House = Stenorrhynchos speciosum (Jacq.) L.C. Rich. ex Spreng.
crystalligerum Salisb. = Sacoila lanceolata (Aubl.) Garay
elatum (Sw.) Salisb. = Beadlea elata (Sw.) Small
floridanum Wherry = Spiranthes floridana (Wherry) Cory
gracile (Bigel.) House = Spiranthes lacera (Raf.) Raf.
incurvum Jennings = Spiranthes cernua (L.) L.C. Rich.
X intermedium (Ames) House = Spiranthes X intermedia Ames
laciniatum (Small) House = Spiranthes laciniata (Small) Ames
longilabre (Lindl.) House = Spiranthes longlabris Lindl.
lucayanum Britt. = Mesadenus lucayanus (Britt.) Schltr.
ochroleucum (Rydb.) House = Spiranthes ochroleuca (Rydb.) Rydb.
odoratum (Nutt.) House = Spiranthes odorata (Nutt.) Lindl.
ovale (Lindl.) House = Spiranthes ovalis Lindl.
parviflorum (Chapm.) Jennings = Spiranthes ovalis Lindl.
plantagineum (Raf.) House = Spiranthes lucida (H.H. Eaton) Ames
porrifolium (Lindl.) Rydb. = Spiranthes porrifolia Lindl.
praecox (Walt.) House = Spiranthes praecox (Walt.) Wats.
quinquelobatum (Poir.) J. Acuña = Spiranthes torta (Thunb.) Garay & Sweet
Romanzoffianum (Cham.) House = Spiranthes Romanzoffiana Cham.
speciosum (Jacq.) Salisb. = Stenorrhynchos speciosum (Jacq.) L.C.Rich. ex Spreng.

spirale (Lour.) Makino = Spiranthes sinensis (Pers.) Ames
spirale (L.) Salisb. = Spiranthes spiralis (L.) Chevall.
strictum (Rydb.) House = Spiranthes Romanzoffiana Cham.
tortile (Sw.) House = Spiranthes torta (Thunb.) Garay & Sweet
trilobum Small = Spiranthes odorata (Nutt.) Lindl.
vernalis (Engelm. & Gray) House = Spiranthes vernalis Engelm. & Gray
viridiflorum (Makino) Makino = Spiranthes sinensis (Pers.) Ames
xyridifolium (Small) Small = Spiranthes vernalis Engelm. & Gray

Kionophyton Garay, gen. nov.

Etymology: *Kion* = pillar, column and *phyton* = plant, in allusion to the pillar-like base of stem below the spreading leaves.

Sepala plus minusve similia, basi connata, nectarium amplum, interdum quasi inflatum formantia, apicibus patentibus; sepalo postico columnae dorsaliter leviter adnato; sepalis lateralibus, obliquis basi connatis ampliatisque, mentum rotundum formantibus. Petala sinuosa, sepalo postico agglutinata, basi obliqua. Labellum breviter unguiculatum, ungue basibus sepalorum lateralium connatorum adnato, deinde anguste auriculatum, auriculis incrassatis; laminae margines in medio utringue lateribus columnae agglutinatae. Columna arcuata, apicem versus dilatata, dorsaliter columnae adnata, basi in pedem obliquum producta, antice sub stigmatibus pubescens; stigmata 2, separata, in forma littera "V" inserta, in medio sese tingentia; rostellum triangulum, breve, apice foveato. Anthera ovato-cucullata, acuta vel obtusa; pollinia clavata viscidio parvo, ovato affixa. Ovarium cylindricum, sessile, tortum.

Plantae terrestres elatae; radicibus fasciculatis, tuberosis, crassis; foliis petiolatis, basi vaginantibus imbricatisque, supra basin rosulatis; caulibus erectis, vaginatis, supra plus minusve dense spicatis; floribus medianis, arcuatis.

Sepals more or less similar, connate at base, at times almost inflated, with divergent, spreading apices; dorsal sepal adnate to back of column for a short distance; lateral sepals oblique at the connate, enlarged base, forming a roundish mentum. Petals sinuous, the internal margins agglutinate with dorsal sepal, oblique at base. Lip with a short claw which is adnate to the fused base of lateral sepals, then narrowly auriculate, auricles fleshy with

thickenings which may be extended along external margins; the margins of the blade in the middle agglutinate with sides of column. Column arcuate, expanded upwards, dorsally fused with median sepal, basally extended into an oblique foot, in front under stigmata pubescent; stigmata 2, separate, touching each other in center and inserted in the form of the letter "V"; rostellum short, triangular with an apical fovea which is easily ruptured. Anther ovate-cucullate, acute to obtuse; pollinia clavate with a small, ovate viscidium. Ovary cylindric, sessile, twisted.

Terrentrial, more or less tall plants. Roots fasciculate, thick, tuberous. Leaves petiolate with tightly imbricating, vaginate bases forming a prominent, pillar-like base below the spreading, rosulate blades. Stem erect, vaginate terminated by a more or less densely, many-flowered spike. Flowers medium-sized, arcuate.

TYPE: *Spiranthes seminuda* Schltr.

Three species native to Mexico and Guatemala.

Index to species

Kionophyton pyramidalis (Lindl.) Garay, comb. nov.
Basionym: Spiranthes pyramidalis Lindl., Gen. and Sp. Orch. Pl. 473, 1840.
Kionophyton Sawyeri (Standl. & L.O. Wms.) Garay, comb. nov.
Basionym: Spiranthes Sawyeri Standl. & L.O.Wms. in Ceiba 3: 194, 1953.
Kionophyton seminuda (Schltr.) Garay, comb. nov.
Basionym: Spiranthes seminuda Schltr. in Fedde, Rep. 3: 18, 1906.

Lankesterella Ames, Sched. Orch. 4: 3, 1923.
Etymology: In honor of Charles H. Lankester (1879 1969), an English naturalist and orchidophile who made his home in Costa Rica.
Syn.: *Cladobium* Schltr. in Beih. Bot. Centralbl. 37 (2): 431, 1920, not Lindl. 1836.
Lectotype: *Spiranthes ceracifolia* Barb.Rodr. *in hoc loco.*

Sepals dissimilar, free to base, subparallel, with spreading apices; dorsal sepal concave, partially adnate to back of column; lateral sepals oblique, with column-foot form either a gibbose mentum or spur-like. Petals agglutinate with dorsal sepal except at spreading apices, sessile or somewhat oblique at base, not truly decurrent. Lip sessile, fused with incurved base of column, broadly concave to gibbose at base, the lateral margins in middle, lightly agglutinate with sides of column, arcuate to recurved at apex. Column moderately short, somewhat arcuate, with a distinct, decurrent incurved foot; stigmata 2, commonly confluent or closely approximate with a bilobed apex; rostellum rigid, more or less unequally 3-dentate, the median tooth always longer, acuminate. Anther ovate-cucullate, acuminate; pollinia narrowly clavate with a prominent, more or less ovate-elliptic viscidium. Ovary subcylindric-fusiform, sessile or subsessile.

Plants small, caespitose, facultative epiphytes, growing among mosses on tree branches. Roots rather slender, fasciculate. Leaves basal, several, sessile, or with a cuneate base, the margins commonly ciliolate. Scape erect, slender, pubescent to villose, loosely few-flowered above. Flowers membranaceous, small to medium in size.

TYPE: *Lankesterella costaricensis* Ames

Eight species native to the American tropics.

Index to species

caespitosa (Lindl.) Hoehne
ceracifolia (Barb.Rodr.) Mansf.
costaricensis Ames = Lankesterella orthantha (Krzl.) Garay
epiphyta (Barb.Rodr.) Mansf. = Lankesterella caespitosa (Lindl.) Hoehne
gnoma (Krzl.) Hoehne
Hoehnei Leite = Lankesterella gnoma. (Krzl.) Hoehne.
longicollis (Cogn.) Hoehne
majus (Hoehne & Schltr.) Hoehne = Lankesterella ceracifolia (Barb.Rodr.) Mansf.
mantiens Hoehne = Lankesterella ceracifolia (Barb.Rodr.) Mansf.
oligantha (Hoehne & Schltr.) Mansf. = Lankesterella ceracifolia (Barb. Rodr.) Mansf.
orthantha (Krzl.) Garay
parvula (Krzl.) Pabst

pilosa (Cogn.) Hoehne
Salehi Pabst = Lankesterella caespitosa (Lindl.) Hoehne
Spannageliana (Hoehne & Brade) Mansf.

Limodorum L.C. Rich.
lanceolatum Aubl. = Sacoila lanceolata (Aubl.) Garay
praecox Walt. = Spiranthes praecox (Walt.) Wats.

Lyroglossa Schltr. in Beih. Bot. Centralbl. 37(2): 448, 1920.
Etymology: *Lyra* = lyre and *glossa* = tongue, describing the shape of the lip characteristic for all species.

Sepals subsimilar, from a subparallel base, divergent; dorsal sepal ovate-lanceolate, deeply concave; lateral sepals spreading with more or less reflexed apex, basally decurrent on short column-foot, without forming a true mentum. Petals variable, the internal margins firmly agglutinate with dorsal sepal, with an oblique, non-decurrent base. Lip membranaceous, panduriform, subsessile, with a very short claw, the margins of which linear, callose-thickened; the margins of the blade above base agglutinate with column on both sides. Column short, dilated above, sulcate and pubescent in front, basally produced in a short foot of same length; stigmata 2, terminal, approximate, touching each other in the middle, more or less cleft by median furrow in front of column; rostellum rigid, acuminate. Anther ovate-cucullate, acute; pollinia clavate with a small, narrowly oblong viscidium. Ovary subsessile, arcuately fusiform to cylindric, more or less lightly twisted.

Terrestrial, small plants, commonly aphyllous during anthesis. Roots fleshy, fusiform-tuberous, pubescent. Leaves when present small, basal, few. Stem slender, erect, remotely many-sheathed, terminated by a rather loosely, several-flowered, more or less spirally twisted spike. Flowers small.

Lectotype: *Spiranthes Grisebachii* Cogn. [Angely, Fl. Analit. S. Paulo 6:1277, 1973]

Three species native to Mexico, Trinidad, Venezuela, Bolivia and Brazil.

Index to species

bicolor (Griseb.) Schltr. = Lyroglossa Grisebachii (Cogn.) Schltr.
Bradei Schltr. ex Mansf. = Pteroglossa Hilariana (Cogn.) Garay
euglossa (Krzl.) Hoehne & Schltr. = Lyroglossa Grisebachii (Cogn.) Schltr.
Grisebachii (Cogn.) Schltr.
pubescens (Barb.Rodr.) Schltr. = Beadlea bicolor (Ker-Gawl.) Garay
Lyroglossa pubicaulis (L.O.Wms.) Garay, comb. nov.
Basionym: Spiranthes pubicaulis L.O. Wms. in Bot. Mus. Leafl. 12:234, 1946.
Rodriguesii Schltr. ex Hoehne, nomen = Lyroglossa Grisebachii (Cogn.) Schltr.
Lyroglossa spirata (Hoehne) Garay, comb. nov.
Basionym: Spiranthes spirata Hoehne in Arch. Mus. Nac. Rio 22: 71, 1919.

Manniella Rchb.f., Otia Bot. Hamburg. 2: 79, Aug. 10, 1881. Reprinted from Verzeichniss der Vorlesungen, welche am Hamburgisches Akademischen Gymnasium von Ostern 1881 bis Ostern 1882 gehalten werden sollen.

Etymology: In honor of Gustav Mann (1836-1916) a German collector and explorer of Cameroon Mountains and of Assam.

All three sepals connate into a cylindrical tube with free, spreading apices; dorsal sepal concave, galeate; lateral sepals oblique, spreading with recurved apices. Petals connivent with dorsal sepal, not agglutinate with it, ovate-elliptic with a long, linear claw which are fully adnate to sepaline tube. Lip unguiculate, the claw fully adnate to front wall of sepaline tube, then sagittate at base with a subquadrate to trapezoid blade; disc very fleshy, heavily papillose-pilose with membranaceous margin, not agglutinate with sides of column. Column elongate, dorsally adnate full length to sepaline tube, apical free portion inclined, basally extended into a short, oblique foot on top of ovary; clinandrium subquadrate with a flat bottom, basket-like, the side walls free, (erroneously described as wings!) serrulate, not connected with sides of stigmatic cavity; stigmata 2, completely confluent; rostellum low, hardly discernible, transverse, emarginate with a small fovea beneath. Anther broad, umbonate, completely hidden in the basket-like clinandrium, subincumbent;

pollinia obovate-clavate with a small, round viscidium. Ovary cylindric, sessile, slightly twisted.

Terrestrial, tall plants. Roots fasciculate, rather slender, villose. Leaves basal, distichous, petiolate with imbricating vaginate base. Stem erect, remotely several bracteolate which decreases upwards in size, terminated by a long loosely many-flowered spike. Flowers small.

TYPE: *Manniella Gustavi* Rchb.f.

One species native to western tropical Africa.

Index to species

americana C. Schweinf. & Garay = Helonoma americana (C. Schweinf. & Garay) Garay
Gustavi Rchb.f.
hongkongensis Hu & Barretto = Pelexia obliqua (J.J.Sm.) Garay

Mesadenella Pabst & Garay in Arquiv. Jard. Bot. Rio 12: 205, 1952.

Etymology: *Mesadenus* = a genus of orchids and *-ella* = a diminutive suffix, suggestive of systematic position in Schlecter's classification of the subtribe Spiranthinae.

Sepals free, dissimilar, subparallel, somewhat diverging towards apex; lateral sepals obliquely decurrent on column-foot forming an obtuse mentum. Petals connivent with dorsal sepal, inner margins agglutinate with dorsal sepal, but apices free. Lip with a distinct claw, saggitate at base; blade conduplicate. Column short, puberulent in front, basally extended into a decurrent, incurved foot, together with lateral sepals forming a distinct mentum; stigmata 2, anterior, approximate, touching each other in middle; rostellum rigid, more or less cartilaginous, linear-subulate, acuminate. Anther entire, concave; pollinia clavate. Anther ovate-lanceolate, acute to subacuminate; pollinia clavate with small, roundish viscidium. Ovary sessile, barely twisted.

Terrestrial plants, very variable in size with fasciculate, fleshy,

fusiform roots. Leaves basal, rosulate, petiolate to cuneate at base. Scape erect, vaginate, terminated by a many-flowered, more or less spirally twisted spike. Flowers small, inconspicuous.

LECTOTYPE: *Spiranthes esmeralda* Linden & Rchb.f. [Correa in Darwiniana 11:68, 1955]

Seven species native to tropical and subtropical America, ranging from Guatemala to Brazil.

Index to species

angustisegmenta Garay
Mesadenella atroviridis (Barb.Rodr.) Garay, comb. nov.
Basionym: Cyclopogon atroviridis Barb. Rodr., Gen. et Sp. Orch, Nov. 2: 284,1881.
cuspidata (Lindl.) Garay
esmeralda (Linden & Rchbhf.) Pabst & Garay = Mesadenella cuspidata (Lindl.) Garay
Mesadenella margaritifera (Linden & Rchb.f.) Garay, comb. nov.
Basionym: Spiranthes margaritifera Linden & Rchb.f. in Gard. Chron. 219, 1866.
peruviana Garay
Mesadenella petenensis (L.O. Wms.) Garay, comb. nov.
Basionym: Spirantheses petenensis L.O. Wms. in Phytologia 25: 460, 1973.
Tonduzii (Schltr.) Pabst & Garay

Mesadenus Schltr. in Beih. Bot. Centralb. 37 (2): 367, 1920.

Etymology: *Mesos* = middle and *aden* = gland, describing the manner how the pollinia are attached to the rostellum.

Sepals more or less similar, subparallel, somewhat diverging towards the arcuately spreading apices, often insignificantly connate basally; dorsal sepal slightly concave and adnate to a short distance to back of column; lateral sepals with an oblique base, adnate to column-foot. Petals agglutinate with dorsal sepal, more or less falcate with a decurrent base. Lip conduplicate to navicular, subsessile with thickened, auriculate base, arcuately recurved in front. Column arcuate, dorsally united with median sepal, basally produced in a decurrent foot; stigmata 2, confluent, sometimes obscurely 2-lobed at apex; rostellum very narrow, emarginate with a small, sometimes rather obscure, dorsal toothlette in middle. Anther bivalvate, rather

deeply cordate at apex, much surpassing the rostellum, during anthesis becomes flattened and arcuately curved backwards; pollinia clavate with an ovate to roundish viscidium. Ovary obliquely fusiform, sessile.

Terrestrial plants with fasciculate, fleshy, tuberous roots. Leaves, when present, basal, petiolate, rosulate. Scape erect, slender, remotely several-vaginate which decrease in size upwards, terminated by a more or less densely many-flowered, commonly secund spike. Flowers small to minute in size.

LECTOTYPE: *Spiranthes Galeottiana* A. Rich. [Britton & Wilson, Sci., Surv. Porto Rico 5(2): 186, 1924]

Eight species native to the American tropics and subtropics.

Index to species

Mesadenus affinis (C. Schweinf.) Garay, comb. nov.
Basionym: Spiranthes affinis C. Schweinf. in Bot. Mus. Leaf. 4: 101, 1937.
Mesadenus Chiangii (Johnst.) Garay, comb. nov.
Basionym: Spiranthes Chiangii Johnst. in Phytologia 45: 449, 1980.
Galeottianus Schltr. = Mesadenus polyanthus (Rchb.f.) Schltr.
Glaziovii (Cogn.) Schltr.
lucayanus (Britt.) Schltr.
minutiflorus (Rich. & Gal.) Schltr. = Microthelys minutiflora (Rich. & Gal.) Garay
polyanthus (Rchb.f.) Schltr.
Mesadenus rhombiglossus (Pabst) Garay, comb. nov.
Basionym: Hapalorchis rhombiglossus Pabst in Bradea 1: 468, 1975.
Mesadenus Stahlii (Cogn.) Garay, comb. nov.
Basionym: Spiranthes Stahlii Cogn. in Urb. Symb. Antill. 6: 341, 1910.
Mesadenus tenuissimus (L.O.Wms.) Garay, comb. nov.
Basionym: Spiranthes tenuissima L.O.Wms. in Bot. Mus. Leafl. 12:235, 1946.

Microthelys Garay, gen. nov.

Etymology: *Micros* = small and *thelys* = female, describing the nature of the rostellum.

Sepala subsimilia, parallela, apicibus leviter divergentibus; sepalo postico concavo, columnae dorsaliter adnato; sepalis lateralibus obliquis, mentum non formantibus. Petala sepalo postico agglutinata, basi oblique decurrentia. Labellum late bre-

viterque unguiculatum, conduplicato-canaliculatum, margine supra basin utrinque lateris columnae agglutinato; disco carnoso, vulgo discolori. Columna arcuata, sursum leviter dilatata, basi in pedem decurrentem, apice paululo incurva producta; stigmata 2, omnino confluentia, subquadrata; rostellum humile, haud productum, transversum, obtusum, apice vulgo persistenter foveato. Anthera ovato-elliptica acuta vel obtusa; pollinia anguste clavata, viscidio parvulo, rotundo. Ovarium cylindricum, vel fusiforme, sessile, leviter tortum.

Herbae terrestres, spithameae, graciles; radicibus tuberosis, villosis; foliis basilaribus vel subbasilaribus, suboppositis, petiolatis; caulibus erectis, vulgo vaginis imbricatis obtectis, supra laxe multifloris; floribus minutis.

Sepals subsimilar, parallel, with somewhat diverging apices; dorsal sepal concave, adnate to back of column; lateral sepals oblique at base without forming a mentum. Petals agglutinate with dorsal sepal, obliquely decurrent at base. Lip with a broad short claw, conduplicate-canaliculate, the margins above the base agglutinate with sides of column; disc fleshy, commonly discolored. Column arcuate, somewhat expanded upwards, basally produced in a decurrent, incurved foot; stigmata 2, completely confluent, subquadrate; rostellum low, hardly noticeable, transverse, commonly with a persistent fovea. Anther ovate-elliptic, obtuse or acute; pollinia narrowly clavate, with a small, round viscidium. Ovary cylindric to fusiform, sessile, somewhat twisted.

Terrestrial, small, slender herbs. Roots tuberous, villose. Leaves basal or subbasal, subopposite, petiolate. Stem erect, commonly enclosed by imbricating sheaths, loosely many-flowered above. Flowers small.

TYPE: *Spiranthes minutiflora* Rich. & Gal.

Three species native to Mexico, Guatemala and Costa Rica.

Index to species

Microthelys minutiflora (Rich. & Gal.) Garay, comb. nov.
Basionym: Spiranthes minutiflora Rich. & Gal. in Ann. Sci. Nat. ser. 3,3:32, 1845.

Microthelys nutantiflora (Schltr.) Garay, comb. nov.
Basionym: Spiranthes nutantiflora Schltr. in Fedde, Rep. 2: 131, 1906.
Microthelys rubrocallosa (Robins. & Greenm.) Garay, comb. nov.
Basionym: Spiranthes rubrocallosa Robins. & Greenm. in Amer. Journ. Sci. 50: 165, 1895.

Monustes Raf.
australis (R.Br.) Raf. = Spiranthes sinensis (Pers.) Ames

Narica Raf.
moschata Raf. = Sarcoglottis acaulis (J.E.Sm.) Schltr.

Neottia Erhart
acaulis J.E.Sm. = Sarcoglottis acaulis (J.E.Sm.) Schltr.
Adnaria Raf. = Pelexia adnata (Sw.) Spreng.
adnata Sw. = Pelexia adnata (Sw.) Spreng.
aestivalis (Poir.) Pers. = Spiranthes aestivalis (Poir.) L.C. Rich.
amoena Bieb. = Spiranthes amoena (Bieb.) Spreng.
aphylla Hook. = Sacoila lanceolata (Aubl.) Garay
aurantiaca Llave & Lex. = Stenorrhynchos aurantiacum (Llave & Lex.) Lindl.
australis R. Br. = Spiranthes sinensis (Pers.) Ames
autumnalis (Balb.) Pers. = Spiranthes spiralis (L.) Chevall.
bicolor Ker-Gawl. = Beadlea bicolor (Ker-Gawl.) Garay
bracteosa (Lindl.) Steud. = Brachystele bracteosa (Lindl.) Schltr.
calcarata Sw. = Eltroplectris calcarata (Sw.) Garay & Sweet
cernua (L.) Willd. = Spiranthes cernua (L.) L.C. Rich.
cinnabarina Llave & Lex. = Dichromanthus cinnabarinus (Llave & Lex.) Garay
crispata Bl. = Spiranthes sinensis (Pers.) Ames
diuretica Willd. = Brachystele unilateralis (Poir). Schltr.
elata (Sw.) Sw. = Beadlea elata (Sw.) Small
flexuosa J.E.Sm. = Spiranthes sinensis (Pers.) Ames
gemmipara J.E.Sm. = Spiranthes Romanzoffiana Cham.
gracilis Bigel. = Spiranthes lacera (Raf.) Raf.
grandiflora (Lindl.) Hook. = Sarcoglottis grandiflora (Lindl.) Kl.
lanceolata (Aubl.) Willd. = Sacoila lanceolata (Aubl.) Garay
lucida H.H.Eaton = Spiranthes lucida (H.H.Eaton) Ames
michuacana Llave & Lex. = Stenorrhynchos michuacanum (Llave & Lex.) Lindl.
micrantha Llave & Lex. = *incerta sedis.*
minor Jacq. = Beadlea elata (Sw.) Small
odorata Nutt. = Spiranthes odorata (Nutt.) Lindl.
orchioides (Sw.) Willd. = Sacoila lanceolata (Aubl.) Garay
papulosa Llave & Lex. = Stenorrhynchos papulosum (Llave & Lex.) Lindl.
parviflora J.E.Sm. = Spiranthes sinensis (Pers.) Ames
picta R.Br. = Sarcoglottis acaulis (J.E.Sm.) Schltr.
plantaginea Raf. = Spiranthes lucida (H.H.Eaton) Ames

plantaginea Hook. = Sacoila lanceolata (Aubl.) Garay
pudica (Lindl.) Sweet = Spiranthes sinensis (Pers.) Ames
quadridentata Willd. = Spiranthes torta (Thunb.) Garay & Sweet
sinensis Pers. = Spiranthes sinensis (Pers.) Ames
speciosa Jacq. = Stenorrhynchos speciosum (Jacq.) L.C. Rich ex Spreng.
spiralis (L.) Pers. = Spiranthes spiralis (L.) Chevall.
spiralis Sw. = Spiranthes torta (Thunb.) Garay & Sweet
squamulosa H.B.K. = Sacoila squamulosa (H.B.K.) Garay
sulphurea Llave & Lex. = Stenorrhynchos michuacanum (Llave & Lex.) Lindl.
tortilis Muhl. = Spiranthes vernalis Engelm. & Gray
tortilis Sw. = Spiranthes torta (Thunb.) Garay & Sweet
vaginata H.B.K. = Stenorrhynchos vaginatum (J.B.K.) Spreng.

Nothostele Garay, gen. nov.

Etymology: *Nothos* = false and *stele* = column, pillar, describing the nature of gynandrium which lacks fusion between the filament and style.

Sepala inequalia, patentissima, basi minutiuscule inter se connata; sepalo postico concavo, basi filamentum antherae liberum adnato; sepalis lateralibus divaricatis, plus minusve arcuatis, lateraliter pedem columnae adnatis et cum eo sacculum brevem, ovarium adpressum formantibus. Petala obliqua, arcuata, sepalo postico agglutinata, basi obliqua. Labellum superum, sessile, in ambitu rhombeum, basi cuneatum, margine incrassatum. Columna horizontalis, gracilis, facie puberula, apicem versus paululo dilatata, basi in pedem longum, apici ovarii oblique extensa; stigmata 2, terminalia, omnino confluentia vel sese arcte adpressa; rostellum longe triangulare acuminatum; clinandrium hyalino-marginatum, haud evolutum. Anthera ovato-ligulata, apice recurva, basi et filamentum eius libera; pollinia clavata, distincte caudiculata, viscidio rotundo, parvo affixa. Ovarium, breviter pedicellatum, cylindricum, non tortum.

Plantae terrestres, sub anthesin aphyllae, radicibus non observatis; caulibus erectis, gracilibus, hyalino-vaginatis, supra laxe paucifloris; racemis quaquaversis; floribus non resupinatis, parvulis, patentibus.

Sepals unequal in size, spreading, rather insignificantly connate at base; dorsal sepal concave, basally adnate to back of free

filament of anther; lateral sepals divaricate, more or less arcuate, adnate to sides of column-foot and with it form a short sac which is adpressed to the ovary. Petals oblique, arcuate, agglutinate with dorsal sepal, oblique at base. Lip uppermost, sessile, rhombic in outline, cuneate at base with thickened margins. Column horizontal, slender, puberulent in front, somewhat dilated upwards, basally extended into a long foot, obliquely inserted on top of ovary; stigmata 2, terminal, completely confluent or tightly adpressed to one another; rostellum long, triangular, acuminate, laminar with revolute margins; clinandrium formed by a narrow, hyaline margin, free from filament of anther. Anther ovate-ligulate, with a recurved apex, and with a free filament; pollinia clavate with distinct caudicles and a small, round viscidium. Ovary pedicellate, cylindric, not twisted.

Terrestrial plants, completely leafless during flowering time. Roots so far unknown. Stem erect, slender with several hyaline sheaths, terminated by a loosely few-flowered, allsided raceme. Flowers not resupinate, small, with spreading segments.

TYPE: *Pelexia acianthiformis* Rchb.f. & Warm.

One species native to Brazil.

Index to species

Nothostele acianthiformis (Rchb.f. & Warm.) Garay, comb. nov.
Basionym: Pelexia acianthiformis Rchb.f. & Warm., Otia Bot. Hamb. 2:53, 1881.

Odontorrhynchus Correa in Darwiniana 10: 157, 1953.

Etymology: *Odontos* = tooth and *rhynchos* = snout, in reference to the dentate rostellum (which is not snout-like) in the type specimen.

Sepals rather dissimilar, free, subparallel with more or less spreading apices; dorsal sepal concave to cucullate, free from column; lateral sepals adnate laterally to column-foot and with it form an obliquely descending, somewhat enlarged, rounded base, not representing a true mentum. Petals linear, agglutinate along inner margins with dorsal sepal. Lip sessile to subun-

guiculate with free, falcate, callose processes at base, not truly sagittate; blade conduplicate-arcuate with the lateral margins agglutinate to sides of column. Column rather short, stout, with an obliquely descending foot; stigmata 2, tightly approximate to confluent, bilobed (not free and separated as stated); rostellum cartilaginous, broadly triangular, acute at the more or less obscurely 3-lobulate to 3-dentate apex, with a large, V-shaped groove in front to accomodate the conspicuous viscidium. Anther ovate-cucullate, acute, cordate at base; pollinia clavate with a conspicuous, more or less elliptic viscidium. Ovary cylindric to obliquely fusiform, subsessile, more or less twisted.

Terrestrial herbs, commonly leafless during anthesis. Roots fasciculate, fusiform, tuberous. Stem erect, completely enclosed by imbricating, sometimes almost foliaceous sheaths, terminated by a densely many-flowered, more or less cylindrical spike. Flowers small.

TYPE: *Stenorrhynchus Castillonii* Haum.

Five species native to Bolivia, Peru, Argentina and Chile.

Index to species

alticola Garay
Castillonii (Haum.) Correa
Odontorrhynchus chilensis (A. Rich.) Garay, comb. nov.
Basionym: Spiranthes chilensis A. Rich. in Gay, Hist. Nat. Chile, Bot. 5: 475, 1852.
Odontorrhynchus chlorops (Rchb.f.) Garay, comb. nov.
Basionym: Spiranthes chlorops Rchb.f., Xenia Orch. 3:20, 1878.
Ghillanyi Pabst = Thelyschista Ghillanyi (Pabst) Garay
variabilis Garay

Ophrys L.
aestiva Balb. = Spiranthes aestivalis (Poir.) L.C. Rich
aestivalis Poir. = Spiranthes aestivalis (Poir.) L.C. Rich.
aestivalis Michx. = Spiranthes vernalis Engelm. & Gray
autumnalis Balb. = Spiranthes spiralis (L.) Chevall.
cernua L. = Spiranthes cernua (L.) L.C. Rich.
peregrina Sessé & Moc. = Dichromanthus cinnabarinus (Llave & Lex.) Garay
peruviana Aubl. = Spiranthes torta (Thunb.) Garay & Sweet
pubescens Sessé & Moc. = Stenorrhynchos aurantiacum (Llave & Lex.) Lindl.

quinquelobata Poir. = Spiranthes torta (Thunb.) Garay & Sweet
spiralis L. = Spiranthes spiralis (L.) Chevall.
torta Thunb. = Spiranthes torta (Thunb.) Garay & Sweet
unilateralis Poir. = Brachystele unilateralis (Poir.) Schltr.

Orchiastrum Seguier
porrifolium (Lindl.) Greene = Spiranthes porrifolia Lindl.
Romanzoffianum (Cham.) Greene = Spiranthes Romanzoffiana Cham.

Orchis L.
ventricosa (Vell.) Steud. = Sarcoglottis ventricosa (Vell.) Hoehne

Pelexia Poit. ex Lindl. in Bot. Reg. 12: sub t. 985, 1826, *nom. cons.*

Etymology: *Pelex* = helmet, in reference to the appearance of the dorsal sepal which together with the petals form a helmet-like structure.

Syn.: *Collea* Lindl. in Bot. Reg. 9: sub t. 760, 1823, *nom. reject.*
Type: *Satyrium adnatum* Sw.
Adnulla Raf., Fl. Tellur. 2: 87, 1837.
Type: *Satyrium adnatum* Sw.

Sepals unequal, ringent; dorsal sepal concave to cucullate, together with petals form a distinct helmet-like structure; lateral sepals more or less porrect, decurrent on the protruding column-foot, basally connate into a ventricose, saccate or spur-like vesicle which is often manifested in a pronounced mentum. Petals connivent with dorsal sepal, decurrent or variously oblique at base. Lip fleshy, prominently unguiculate, fleshy-sagittate at base, rarely auriculate, lateral margins agglutinate with sides of column. Column rather stout, elongate, puberulent or pilose in front, basally produced in a decurrent foot which often protrudes from the wall of the ovary; stigmata 2, separate to variously approximate; rostellum rather soft, pliable, laminar, linear-oblong to ligulate, obtuse or truncate. Anther ovate-cordate, obtuse; pollinia clavate with a thick, ovate to suborbicular viscidium. Ovary cylindric to more or less fusiform, sessile or subsessile, somewhat twisted.

Terrestrial herbs, rarely subaquatic or hydrophilous. Roots fasciculate, fleshy, stipitate to fusiform. Leaves when present

basal, petiolate, rarely withered during anthesis. Scape erect, vaginate to bracteate, terminated by a loosely to densely, many-flowered spike. Flowers commonly medium to large in size.

TYPE: *Satyrium adnatum* Sw.

67 species native to the tropics and subtropics of the New World.

Index to species

acianthiformis Rchb.f. & Warm. = Nothostele acianthiformis (Rchb.f. & Warm.) Garay
adnata (Sw.) Spreng.
albicans (Cogn.) Schltr.
aphylla Ridl. 1886 = Sarcoglottis aphylla (Ridl.) Schltr.
aphylla (Vell.) Schltr. 1920 = Pelexia Arrabidae (Rchb.f.) Garay
Pelexia Arrabidae (Rchb.f.) Garay, comb. nov.
Basionym: Stenorrhynchus Arrabidae Rchb.f. in Linnaea 22: 815, 1850.
Berroana (Krzl.) Schltr. = Skeptrostachys Berroana (Krzl.) Garay
bonariensis (Lindl.) Schltr.
Bradei Schltr. ex Mansf.
Burgeri Schltr.
bursaria Lindl. = Erythrodes plantaginea (L.) Fawc. & Rendl.
calcarata (Sw.) Cogn. = Eltroplectris calcarata (Sw.) Garay & Sweet
callifera (C. Schweinf.) Garay
callosa Ames 1924 = Pelexia Funckiana (Rich. & Gal.) Schltr.
callosa Correa 1953 = Pelexia bonariensis (Lindl.) Schltr.
calophylla (Porsch) Schltr. = Pelexia novofriburgensis (Rchb.f.) Garay
Caucae Schltr.
Pelexia cerina (Lindl.) Garay, comb. nov.
Basionym: Spiranthes cerina Lindl. in Bot. Reg. 28: Misc. p. 20, 1842.
comosa (Cogn.) Schltr.
congesta A. & S. = Pelexia Funckiana (Rich. & Gal.) Schltr.
corymbosa (Lindl.) Lindl. = Sauroglossum corymbosum (Lindl.) Garay
cranichoides Griseb. = Beadlea cranichoides (Griseb.) Small
cuculligera (Rchb.f. & Warm.) Schltr.
Pelexia decora (Garay) Garay, comb. nov.
Basionym: Spiranthes decora Garay in Can. Journ. Bot. 34: 248, 1956.
dolichorhiza Schltr.
domingensis Lindl. = Eletroplectris calcarata (Sw.) Garay & Sweet
ecuadorensis Schltr.
Ekmanii (Krzl.) Schltr.
falcata (Thunb.) Spreng. = Cephalanthera falcata (Thunb.) Bl.
Fiebrigii Schltr. = Pelexia Mandonii (Rchb.f.) Schltr.
foliosa Poepp. & Endl. = Aspidogyne foliosa (Poepp. & Endl.) Garay
Funckiana (Rich. & Gal.) Schltr.

Glazioviana Cogn. = Pteroglossa Glazioviana (Cogn.) Garay
goninensis (Pulle) Schltr.
Pelexia goyazensis (Cogn.) Garay, comb. nov.
Basionym: Spiranthes goyazensis Cogn. in Mart.,Fl. Bras. 3(6): 542,1906.
gracilis Schltr.
guatemalensis Schltr. = Pelexia Funckiana (Rich. & Gal.) Schltr.
Pelexia gutturosa (Rchb.f.) Garay, comb. nov.
Basionym: Spiranthes gutturosa Rchb.f., Beitr. Orch. Centr. Amer. 67, 1866.
hamata Schltr.
Hameri Garay = Pelexia obliqua (J.J.Sm.) Garay
Hilariana (Cogn.) Schltr. = Pteroglossa Hilariana (Cogn.) Garay
hirta (Lindl.) Schltr.
Hoffmannii Rchb.f. = Pseudocentrum Hoffmannii (Rchb.f.) Rchb.f.
hondurensis Ames = Pelexia Funckiana (Rich. & Gal.) Schltr.
hypnophila (Barb.Rodr.) Schltr. = Pelexia novofriburgensis (Rchb.f.) Garay
hysterantha (Barb.Rodr.) Schltr.
incurvidens Schltr.
itatiaiae Schltr.
japonica Spreng. = Cephalanthera erecta (Thunb.) Bl.
laminata Schltr.
laxa (Poepp. & Endl.) Lindl.
Lehmanniana Krzl. = Pelexia olivacea Rolfe
leucosticta (Rchb.f.) Garay & Dunsterv. = Pelexia novofriburgensis (Rchb.f.) Garay
Lindmaniana (Krzl.) Schltr.
Lindmanii Krzl.
Pelexia lobata (Lindl.) Garay, comb. nov.
Basionym: Spiranthes lobata Lindl. in Bot. Reg. 30: Misc. p. 11, 1844.
Loefgrenii (Porsch) Schltr.
longibracteata Pabst
longicornu Cogn. = Eltroplectris longicornu (Cogn.) Pabst
longifolia (Cogn.) Hoehne
longipetiolata (Rchb.f.) Schltr. = Pelexia laxa (Poepp. & Endl.) Lindl.
Leutzenburgii Schltr.
macropoda (Barb.Rodr.) Schltr.
maculata Rolfe = Pelexia laxa (Poepp. & Endl.) Lindl.
magdalensis Brade & Pabst = Pelexia sancta (Rchb.f. & Warm.) Garay
Madonii (Rchb.f.) Schltr.
mattogrossensis (Hoehne) Hoehne = Pelexia cuculligera (Rchb.f. & Warm.) Schltr.
matucanensis (Krzl.) Schltr.
Maxonii Ames
minarum (Krzl.) Schltr.
Mouraei Schltr.
neottiorhiza (Krzl.) Pabst
Pelexia novofriburgensis (Rchb.f.) Garay, comb. nov.
Basionym: Stenorrhynchus novofriburgensis Rchb.f. in Linnaea 22: 815, 1850.

Pelexia obliqua (J.J.Sm.) Garay, comb. nov.
Basionym: Spiranthes obliqua J.J.Sm. in Bull. Dept. Agric. Ind. Neerl. 43: 74, 1910.
oestrifera (Rchb.f. & Warm.) Schltr.
olivacea Rolfe
orobanchoides (Krzl.) Schltr.
orthosepala (Rchb.f. & Warm.) Schltr.
ovatifolia Correa
paludosa Correa
Pelexia paraguayensis Garay, nom. nov.
Basionym: Stenorrhynchus vaginatus Cogn. in Bull. Soc. Roy. Belg. 43:290, 1906, not Spreng. 1826.
parva (Cogn.) Schltr.
pauciflora Poepp. & Endl. = Eltroplectris pauciflora (Poepp. & Endl.) Garay
Pelexia Pavonii (Rchb.f.) Garay, comb. nov.
Basionym: Spiranthes Pavonii Rchb.f. in Bonpl. 4: 211, 1856.
polyantha Schltr. ex Mansf. = Pelexia novofriburgensis (Rchb.f.) Garay
Pringlei Fern. = Pelexia Funckiana (Rich. & Gal.) Schltr.
pterygantha (Rchb.f. & Warm.) Schltr.
repens Poepp. & Endl. = Aspidogyne repens (Poepp. & Endl.) Garay
Pelexia Richardiana (Schltr.) Garay, comb. nov.
Basionym: Spiranthes Richardiana Schltr. in Beih. Bot. Centralb. 36(2): 435, 1918.
robusta (Krzl.) Schltr.
roseoalba Rchb.f. = Eltroplectris roseoalba (Rchb.f.) Hamer & Garay
saccata Rolfe = Pelexia Schaffneri (Rchb.f.) Schltr.
saltensis (Griseb.) Schltr.
Pelexia sancta (Rchb.f. & Warm.) Garay, comb. nov.
Basionym: Spiranthes sancta Rchb.f. & Warm. Otia Bot. Hamb. 2:85 1881.
sceptrum Schltr.
Schaffneri (Rchb.f.) Schltr.
setacea Lindl. = Eltroplectris calcarata (Sw.) Garay & Sweet
Pelexia Smithii (Rchb.f.) Garay, comb. nov.
Basionym: Spiranthes Smithii Rchb.f. in Gard. Chron. 842, 1868.
Sodiroi Schltr. = Pelexia hirta (Lindl.) Schltr.
spiranthoides Lindl. = Pelexia adnata (Sw.) Spreng.
stenantha (Cogn.) Schltr.
stenorrhynchoides Griseb. = Pelexia adnata (Sw.) Spreng.
stictophylla Schltr. = Pelexia Lindmanii Krzl.
subaequalis Ames = Pelexia Funckiana (Rich. & Gal.) Schltr.
tamanduënsis (Krzl.) Schltr.
tenuior Schltr.
tomentosa (Vell.) Schltr. = Sacoila lanceolata (Aubl.) Garay
tovarensis (Garay & Dunsterv.) Garay & Dunsterv.
trachyglossa (Krzl.) Pabst = Pelexia cuculligera (Rchb.f. & Warm.) Schltr.
Travassosii Rolfe = Eltroplectris Travassosii (Rolfe) Garay
triloba Lindl. = Eltroplectris triloba (Lindl.) Pabst
vaginata (Cogn.) Schltr. = Pelexia paraguayensis Garay

ventricosa (Cogn.) Schltr.
viridis (Cogn.) Schltr.
Weberbaueri (Krzl.) Schltr.
Weberbauerana (Krzl.) Schltr. Sphalm. = Pelexia Weberbaueri (Krzl.) Schltr.
Weirii (Rchb.f.) Schltr. = Pelexia laxa (Poepp. & Endl.) Lindl.
Wendlandiana Krzl. = Pelexia olivacea Rolfe
yungasensis (Rolfe) Schltr.

Physogyne Garay, gen. nov.

Etymology: *Physao* = distend, inflate and *gyne* = female, in reference to the column which is ballooned out in front.

Sepala similia, conniventia, subparallela; sepalo postico concavo, usque ad basin libero; sepalis lateralibus inter se breviter connatis, gibbum minutum, rotundatum formantibus. Petala obliqua vel subfalcata, margine interiori sepalo postico agglutinata. Labellum breviter unguiculatum, ungue basi sepalorum lateralium adnato, deinde cordatum, apicem versus attenuatum, disco juxta unguem utrinque cornu carnoso, falcato ornato. Columna erecta, arcuatim convexa, basi obliqua, facie pubescens; stigmata 2, confluentia, apice biloba; rostellum elongatum, lineare. Anthera ovato-lanceolata, acuminata, valde concava, basi cordata; pollinia clavata, viscidio parvo, elliptico affixa. Ovarium cylindricum vel fusiforme, sessile, vix tortum.

Plantae terrestres, pedales; radicibus fasciculatis, tuberosis, pubescentibus; foliis plurimis, basalibus, cuneatis, sub anthesin persistentibus vel emarcidis; caulibus erectis, vaginatis, sursum laxe spicatis, multifloris; floribus minutis.

Sepals similar, connivent, subparallel; dorsal sepal concave, free to base; lateral sepals basally connate for a short distance, forming a small, round, gibbose base. Petals oblique or subfalcate, the inner margin agglutinate with dorsal sepal. Lip with a short claw which is fused with the connate gibbose part of lateral sepals, cordate at base, attenuate toward apex; disc with a pair of fleshy, falcate horns on both sides of the claw. Column erect, arcuately convex in front, ballooned out, due to inflated clinandrium, pubescent below stigmata, oblique at base; stigmata 2, confluent, with a bilobed apex; rostellum elongate, linear. Anther ovate-lanceolate, acuminate, deeply concave, with a cor-

date base; pollinia clavate with a small, elliptic viscidium. Ovary cylindric or fusiform, sessile, hardly if ever twisted.

Terrestrial plants. Roots fasciculate, tuberous, pubescent. Leaves several, basal, cuneate, commonly present during flowering time, but may also be in the process of withering. Stem erect, completely covered with approximate sheaths, terminated by a long, loosely many-flowered spike. Flowers small to minute.

TYPE: *Spiranthes Gonzalesii* L.O.Wms.

Two species native to Mexico.

Index to species.

Physogyne Gonzalesii (L.O.Wms.) Garay, comb. nov.
Basionym: Spiranthes Gonzalesii L.O.Wms. in Bot. Mus. Leafl. 12:229, 1946.

Physogyne sparsiflora (C. Schweinf.) Garay comb. nov.
Basionym: Spiranthes sparsiflora C. Schweinf. in Bot. Mus. Leafl. 4:108, 1937.

Physurus L.C.Rich. ex Lindl.
pauciflorus (Poepp. & Endl.) Lindl. = Eltroplectris pauciflora (Poepp. & Endl.) Garay

Pseudocranichis Garay, gen. nov.

Etymology: *Pseudo* = false and *Cranichis* = generic name, signifying the mistaken assignment of the type species to the genus Cranichis.

Sepala similia, ringentia; sepalo postico infero, concavo, columnae basin dorsaliter adnato; sepalis lateralibus praecipue basin breviter connatis, superis, leviter divaricatis, cum ungue labelli gibbum parvulum, rotundum vel subbilobum formantibus. Petala libera, apice erosula. Labellum superum unguiculatum, conduplicatum, margine in medio lateribus columnae agglutinatum, basi sagittatum, apice grosse lacerato-bilobum; disco in medio 3-calloso, distincte pubescenti. Columna crassa, humilis, basi oblique extensa, sursum sensim dilatata, apice truncata, antice in medio costata, facie omnino puberula; stigmata 2, lateralia, ephippioidea, quam rostellum longiora; rostellum truncatum, foveatum. Anthera erecta, ovato-oblonga, ob-

tusa, basi subcordata; pollinia clavata, viscidio parvulo, truncato affixa. Ovarium cylindricum, sessile, non tortum.

Plantae terrestres; radicibus fasculatis crassis, fusiformibus; foliis 2-3, basilaribus cuneatis, sessilibus; scapo suberecto vel arcuato, gracili, remote pauci vaginato, supra spicato, laxe multifloro; floribus parvis, non resupinatis.

Sepals similar, ringent; dorsal sepal lowermost, concave, at base adnate to back of column; lateral sepals shortly connate at base, uppermost, somewhat divaricate, fused with the claw of lip and together form a small, round, or bilobed gibbosity. Petals free with erose apex. Lip uppermost, unguiculate, the margins in the middle agglutinate with sides of column, saggitate at base, coarsely lacerate, bilobed at apex; disc with 3 callose-thickened veins in middle, distinctly pubescent. Column fleshy, short with an obliquely extended base, gradually expanded upwards, truncate at apex, with a median costa in front which extends into the claw of the lip; whole of front puberulent; stigmata 2, lateral, saddle-shaped, longer than the rostellum; rostellum truncate, foveate. Anther erect, ovate-oblong, obtuse, subcordate at base; pollinia clavate with a small, truncate viscidium. Ovary cylindric, sessile, not twisted.

Terrestrial plants. Roots fleshy, fusiform, fasciculate. Leaves 2 to 3, basal, cuneate, sessile. Scape suberect to arcuate, rather slender, remotely few-sheathed, terminated by a laxly many-flowered spike. Flowers small, not resupinate.

TYPE: *Cranichis thysanochila* Robins. & Greenm.

One species native to Mexico, State of Oaxaca.

Index to species

Pseudocranichis thysanochila (Robins. & Greenm.) Garay, comb. nov.
Basionym: Cranichis thysanochila Robins. & Greenm. in Proc. Amer. Acad. Sci. 32: 35, 1896.

Pseudoeurystyles Hoehne
Cogniauxii (Krzl.) Hoehne = Eurystyles Cogniauxii (Krzl.) Schltr.
Gardneri (Lindl.) Hoehne = Eurystyles Gardneri (Lindl. ex Gardn.) Garay
Lorenzii (Cogn.) Hoehne = Eurystyles Lorenzii (Cogn.) Schltr.
Schwackeana Hoehne = Eurystyles Lorenzii (Cogn.) Schltr.

Pseudogoodyera Schltr. in Beih. Bot. Centralbl. 37(2): 369, 1920.

Etymology: *Pseudo* = false and *Goodyera* = generic name, signifying the mistaken assignment of the type species to the genus Goodyera.

Sepals similar, free to base; dorsal sepal concave; lateral sepals oblique at base. Petals for the most part with inner margins agglutinate to dorsal sepal, the apex free, basally not decurrent. Lip from a broadly cuneate-unguiculate base cordate-cochleate, rather fleshy with thin margins and with a transverse ridge above the base on the disc. Column very short, arcuate, minutely puberulent in front, basally produced in a short, somewhat incurved foot on top of ovary; stigmata 2, confluent, transversely reniform; rostellum rather short, trapezoid, emarginate. Anther broadly ovate-elliptic, obtuse to rounded at apex; pollinia clavate with a small, oval to subrotund viscidium. Ovary sessile, fusiform, slightly twisted.

Terrestrial, delicate plants with caespitose, fleshy, more or less fusiform roots. Leaves basal, petiolate, rosulate. Stem erect, rather slender, heavy bracteolate throughout, terminated by a rather densely, many-flowered, quaquaversal spike. Flowers minute, subglobose.

TYPE: *Goodyera Wrightii* Rchb.f.

One species native to Mexico, Guatemala and the West Indies.

Index to species

Wrightii (Rchb.f.) Schltr.

Pterichis Lindl.

Widgrenii (Rchb.f.) Cogn. = Brachystele Widgrenii (Rchb.f.) Schltr.

Pteroglossa Schltr. in Beih. Bot. Centralbl. 37(2): 450, 1920.

Etymology: *Pteron* = wing and *glossa* = tongue, in reference to the prominent lateral lobes of the lip in the plants originally assigned to the genus.

Syn.: *Cogniauxiocharis* (Schltr.) Hoehne in Arq. Bot. Estad. S. Paulo, ser. 2, 1: 132, 1944.

Type: *Pelexia Glazioviana* Cogn.

Sepals very unequal, spreading; dorsal sepal concave, together with the petals form a semiopen hood; lateral sepals decurrent on column-foot, for the most part adnate to ovary, except at basal free tip, never spur-like. Petals obliquely cuneate, agglutinate with dorsal sepal, with a decurrent base. Lip sessile or subsessile with thickened basal margins, then long-ligulate to cuneate towards apex. Column short, erect, sulcate in front, basally produced in a long foot which is adnate to ovary wall for the most part, except at the free tip; stigmata terminal, 2 or deeply bilobed, more or less separated from one another by the terminal edge of a distinct fold running full length on face of column; rostellum rigid, sharp-pointed, more or less triangular. Anther ovate, obtuse, deeply concave; pollinia clavate with oblong to subrotund viscidium. Ovary sessile, cylindric to fusiform, hardly twisted.

Terrestrial, tall plants. Roots fasciculate, fleshy, stipitate-fusiform. Leaves basal in a rosette, either synanthus or hysteranthus, with a cuneate base. Scape erect, vaginate or bracteolate, terminated by a many-flowered spike. Flowers conspicuous.

LECTOTYPE: *Spiranthes macrantha* Rchb.f. [Angely, Fl. Analit. S. Paulo 6: 1277, 1973]

Eight species native to South America.

Index to species

Pteroglossa euphlebia (Rchb.f.) Garay, comb. nov.
Basionym: Spiranthes euphlebia Rchb.f. in Gartenfl. 32: 3, 1883.
Pteroglossa Glazioviana (Cogn.) Garay, comb. nov.
Basionym: Pelexia Glazioviana Cogn. in Mart., Fl. Bras. 3(4): 157, 1895.
Pteroglossa Hilariana (Cogn.) Garay, comb. nov.
Basionym: Stenorrhynchus Hilarianus Cogn. in Mart. Fl. Bras. 3(6): 541, 1906.
Pteroglossa lurida (Correa) Garay, comb. nov.
Basionym: Centrogenium luridum Correa in Bol. Soc. Arg. Bot. 14: 319, 1972.
luteola Garay
macrantha (Rchb.f.) Schltr.
regia (Krzl.) Schltr.
rhombipetala Garay

Sacoila Raf., Fl. Tellur. 2: 86, 1837.

Etymology: *Saccos* = bag and *koilos* = hollow, describing the spur-like extension formed by the bases of the lateral sepals.

Sepals free, subsimilar connivent; dorsal sepal concave; lateral sepals decurrent on column-foot, and together form a more or less free-projecting, spur-like extension. Petals agglutinate with dorsal sepal, basally decurrent on column-foot. Lip sessile, from a cuneate base conduplicate, somewhat arcuate, margins in middle agglutinate with sides of column, at base with linear thickenings. Column short, stout, basally extended in a long foot which is decurrent on sides of ovary with the end protruding into a free tip; stigmata terminal, 2, confluent; rostellum rigid, linear-acicular, sharp-pointed. Anther ovate, acute or acuminate, concave, much shorter than the rostellum; pollinia narrowly clavate with a linear viscidium. Ovary clavate to fusiform, with a short pedicel, somewhat twisted.

Terrestrial plants. Roots fasciculate, tuberous. Leaves commonly hysteranthus, when synanthus either basal or cauline, cuneate, sessile. Stem erect, vaginate or bracteolate, terminated by subdense, many-flowered raceme. Flowers large, often showy.

TYPE: *Neottia aphylla* Hook.

Ten species native to the tropics and subtropics of the New World.

Index to species

Sacoila apetala (Krzl.) Garay, comb. nov.
Basionym: Stenorrhynchus apetalus Krzl. in Fedde, Rep. 6: 23, 1908.

Sacoila argentina (Griseb.) Garay, comb. nov.
Basionym: Stenorrhynchus argentinus Griseb., Symb. Fl. Argent. 339, 1879.

Sacoila Duseniana (Krzl.) Garay, comb. nov.
Basionym: Stenorrhynchus Dusenianus Krzl. in Svensk Vet. Akad. Handl. 46(10): 28: 1911.

Sacoila foliosa (Schltr.) Garay, comb. nov.
Basionym: Stenorrhynchus foliosus Schltr. in Fedde, Rep. 17: 12, 1920.

Sacoila Hassleri (Cogn.) Garay, comb. nov.
Basionym: Stenorrhynchus Hassleri Cogn. in Mart., Fl. Bras. 3(6): 534, 1906.

Sacoila lanceolata (Aubl.) Garay, comb. nov.
Basionym: Limodorum lanceolatum Aubl., Hist. Pl. Guiane Fr. 2: 821, 1775.
lurida Raf. = Sacoila lanceolata (Aubl.) Garay
Sacoila pedicellata (Cogn.) Garay, comb. nov.
Basionym: Stenorrhynchus pedicellatus Cogn. in Mart., Fl. Bras. 3 (6): 539, 1906.
Sacoila riograndensis (Krzl.) Garay, comb. nov.
Basionym: Stenorrhynchus riograndensis Krzl. in Svensk Vet. Akad. Handl. 46 (10): 28, 1911.
Sacoila secundiflora (Lillo & Haum.) Garay, comb. nov.
Basionym: Stenorrhynchus secundiflorus Lillo & Haum. in Anal. Soc. Cienc. Argent. 90: 134, 1921.
Sacoila squamulosa (H.B.K.) Garay, comb. nov.
Basionym: Neottia squamulosa H.B.K., Nov. Gen. et Sp. Pl. 1: 332, 1816.

Sarcoglottis Presl, Rel. Haenk. 1: 95, 1827.
Etymology: *Sarc* = flesh and *glotta* = tongue, describing the texture of the lip in the type specimen.
Syn.: *Narcia* Raf., Fl. Tellur 2: 87, 1827.
Type: *Neottia acaulis* J.E.Sm.
Synoplectris Raf., Fl. Tellur. 2: 89, 1837.
Lectotype: *Neottia grandiflora* Hook., *in hoc loco*.

Sepals very unequal, subparallel with spreading apices; dorsal sepal erect, concave; lateral sepals long-decurrent on ovarian wall without any observable line of adnation, the free apices more or less falcate. Petals agglutinate with dorsal sepal, decurrent at base. Lip unguiculate, distinctly sagittate at base, margins near middle agglutinate with sides of column, usually with a reflexed terminal lobe. Column rather short with a long foot which is embedded full length internally in ovarian tissue and with it the more or less connate lateral sepals form a prominent, internal nectary or cuniculus, not discernible externally; stigmata 2, free to approximate, more or less touching each other in middle; rostellum laminar, soft, ligulate, more or less truncate. Anther ovate, cordate, obtuse; pollinia clavate with large, thick viscidium. Ovary sessile, more or less fusiform, hardly twisted.

Terrestrial plants, very variable in habit. Roots fasciculate, fleshy, tuberous. Leaves, when present, basal, rosulate, subsessile. Scape erect, slender to stout, vaginate, terminated by a few- to many-flowered spike. Flowers fleshy, mostly showy.

TYPE: *Sarcoglottis speciosa* Presl.

35 species native to the New World tropics and subtropics.

Index to species.

acaulis (J.E.Sm.) Schltr.
Sarcoglottis acutata (Rchb.f. & Warm.) Garay, comb. nov.
Basionym: Spiranthes acutata Rchb.f. & Warm., Otia Bot. Hamb. 2: 84, 1881.
albiflos Schltr. ex Hoehne, Nomen = Sarcoglottis rupicola Garay
Alexanderi Schltr. ex Mansf.
Allemanii (Barb.Rodr.) Schltr. = Sarcoglottis acaulis (J.E.Sm.) Schltr.
amazonica Pabst
aphylla (Ridl.) Schltr.
Arrabidae (Rchb.f.) Rchb.f. = Pelexia Arabidae (Rchb.f.) Garay
assurgens (Rchb.f.) Schltr.
biflora (Vell.) Schltr.
Bradei Schltr. = Pelexia Smithii (Rchb.f.) Garay
butantanensis (Hoehne) Hoehne & Schltr. = Sarcoglottis neuroptera (Rchb.f. & Warm.) Schltr.
camposnovensis (Hoehne) Hoehne = Sarcoglottis simplex (Griseb.) Schltr.
cerina (Lindl.) P.N.Don = Pelexia cerina (Lindl.) Garay
Cogniauxiana (Barb.Rodr.) Schltr.
Sarcoglottis corymbosa Garay, nom. nov.
Basionym: Spiranthes pauciflora Rich. & Gal. in Ann. Sci. Nat. ser. 3, 3: 32 1845, not Raf. 1833.
diaphana (Lindl.) P.N.Don = Deiregyne diaphana (Lindl.) Garay
diuretica (Lindl.) P.N.Don = Brachystele unilateralis (Poir.) Schltr.
elata (Sw.) P.N.Don = Beadlea elata (Sw.) Small
eriophora (Robins. & Greenm.) Conzatti = Deiregyne eriophora (Robins. & Greenm.) Garay
fasciculata (Vell.) Schltr.
glaucescens Schltr.
Glazioviana (Cogn.) Schltr. ex Pabst = Pelexia goyazensis (Cogn.) Garay
grandiflora (Lindl.) Kl.
gutturosa (Rchb.f.) Ames = Pelexia gutturosa (Rchb.f.) Garay
Hassleri (Cogn.) Schltr.
hemichrea (Lindl.) Ames = Aulosepalum hemichrea (Lindl.) Garay
Heringeri Pabst
Herzogii Schltr.
homalogastra (Rchb.f. & Warm.) Schltr.
hondurensis (Schltr.) Ames ex Standley & Calderon = Gularia trilineata (Lindl.) Garay
Hunterana Schltr. = Sarcoglottis acaulis (J.E.Sm.) Schltr.
imitans Schltr. ex Hoehne, Nomen = Sarcoglottis simplex (Griseb.) Schltr.
itararensis (Krzl.) Hoehne
Juergensii Schltr.
latifolia (Rich. & Gal.) Schltr. = Pelexia Richardiana (Schltr.) Garay
Lehmannii Garay
lithophila Barb.Rodr. = Sarcoglottis biflora (Vell.) Schltr.

lobata (Lindl.) P.N.Don = Pelexia lobata (Lindl.) Garay
Maasorum Pabst
magdalensis (Brade & Pabst) Pabst = Pelexia sancta (Rchb.f. & Warm.) Garay
metallica (Rolfe) Schltr.
misera (Krzl.) Pabst
multiflora Barb.Rodr. = Skeptrostachys balanophorostachya (Rchb.f. & Warm.) Garay
Nelsonii (Greenm.) Conzatti = Aulosepalum Nelsonii (Greenm.) Garay
neuroptera (Rchb.f. & Warm.) Schltr.
novofriburgensis (Rchb.f.) Schltr. = Pelexia novofriburgensis (Rchb.f.) Garay
oaxacana (Robins. & Greenm.) Conzatti = Deiregyne diaphana (Lindl.) Garay
ochracea (Rich. & Gal.) Schltr. = Sarcoglottis rosulata (Lindl.) P.N.Don
olivacea (Rolfe) Schltr. = Beadlea olivacea (Rolfe) Garay
orbiculata Ames = Sarcoglottis rosulata (Lindl.) P.N.Don
ornithocephala Barb.Rodr. = Sarcoglottis fasciculata (Vell.) Schltr.
pauciflora (Rich. & Gal.) Schltr. = Sarcoglottis corymbosa Garay
Pavonii (Rchb.f.) Schltr. = Pelexia Pavonii (Rchb.f.) Garay
picta (R.Br.) Kl. = Sarcoglottis acaulis (J.E.Sm.) Schltr.
Powellii Schltr. = Sarcoglottis acaulis (J.E.Sm.) Schltr.
pubilabia Ames = Pelexia Schaffneri (Rchb.f.) Schltr.
pudica (Lindl.) P.N.Don = Spiranthes sinensis (Pers.) Ames
Purpusiorum Schltr. = Sarcoglottis acaulis (J.E.Sm.) Schltr.
rosulata (Lindl.) P.N.Don
rufescens Kl. = Sarcoglottis ventricosa (Vell.) Hoehne
rupestris Barb.Rodr. = Sarcoglottis rupicola Garay
Sarcoglottis rupicola Garay, nom. nov.
Basionym: Spiranthes rupestris Barb.Rodr., Gen. et Sp. Orch. Nov. 1: 189, 1877, not Lindl. 1840.
sagittata (Rchb.f. & Warm.) Schltr.
sancta (Rchb.f. & Warm.) Schltr. = Pelexia sancta (Rchb.f. & Warm.) Garay
sceptrodes (Rchb.f.) Schltr.
Schaffneri (Rchb.f.) Ames = Pelexia Schaffneri (Rchb.f.) Schltr.
Schwackei (Cogn.) Schltr.
simplex (Griseb.) Schltr.
sincorensis (Schltr.) Schltr.
Smithii (Rchb.f.) Schltr. = Pelexia Smithii (Rchb.f.) Garay
speciosa Presl = Sarcoglottis acaulis (J.E.Sm.) Schltr.
tenuiflora (Greenm.) Conzatti = Aulosepalum tenuiflorum (Greenm.) Garay
tenuis Schltr. = Sarcoglottis neuroptera (Rchb.f. & Warm.) Schltr.
Thelymitra (Rchb.f.) Ames = Gularia trilineata (Lindl.) Garay
uliginosa Barb.Rodr.
umbrosa (Barb.Rodr.) Schltr.
valida Ames = Pelexia Smithii (Rchb.f.) Garay
velata (Robins. & Fern.) Conzatti = Deiregyne velata (Robins. & Fern.) Garay

ventricosa (Vell.) Hoehne
villosa (Poepp. & Endl.) Schltr.
Sarcoglottis Woodsonii (L.O.Wms.) Garay, comb. nov.
Basionym: Spiranthes Woodsonii L.O.Wms. in Ann. Mo. Bot. Gard. 29: 337, 1942.
zamororae Ames = Pelexia Schaffneri (Rchb.f.) Schltr.

Satyrium Sw.
adnatum Sw. = Pelexia adnata (Sw.) Spreng.
elatum Sw. = Beadlea elata (Sw.) Small
orchioides Sw. = Sacoila lanceolata (Aubl.) Garay
spirale Sw. = Spiranthes torta (Thunb.) Garay & Sweet

Sauroglossum Lindl. in Bot. Reg. 19: t. 1618, 1833.
Etymology: *Saura* = lizard and *glossa* = tongue. According to Lindley "the leaves may be compared to the tongue of antedeluvian Saurians, and the sepals to those of modern species."
Syn.: *Synassa* Lindl. in Bot. Reg. 19: sub t. 1618, 1833.
Type: *Synassa corymbosa* Lindl.

Sepals subsimilar, unequal, rather fleshy, free; dorsal sepal erect, concave; lateral sepals decurrent on column-foot, and with it form a short, rounded chin. Petals thinner in texture, agglutinate with dorsal sepal. Lip sessile, rather fleshy, with a long, channelled base, cochleate in front, at base with linear, fleshy, marginal or intramarginal thickenings or calli. Column slender, elongate, somewhat dilated above, and with a short, but distinct, obliquely decurrent foot; stigmata 2, lateral on sides of rostellum, separated by a median groove on face of column; rostellum membranaceous, short, broadly triangular which is extended into a thin clinandrium, and with an apical fovea. Anther ovate-umbonate; pollinia clavate with a small, round viscidium. Ovary arcuate, more or less cylindric, subsessile, somewhat twisted.

Terrestrial, tall plants. Roots fasciculate, fleshy, fusiform. Leaves either synanthous or hysteranthous, basal, cuneate petiolate. Stem erect, vaginate, terminated by a loosely to densely many-flowered spike. Flowers small to medium in size, commonly quaquaversal.

TYPE: *Sauroglossum elatum* Lindl.

Nine species native to South America.

Index to species.

andinum (Haum.) Garay
aurantiacum (C. Schweinf.) Garay
candidum Krzl. = Hapalorchis candidus (Krzl.) Schltr.
corymbosum (Lindl.) Garay
cranichoides (Griseb.) Ames = Beadlea cranichoides (Griseb.) Small
distans Lindl. ex Garay
elatum (Rich.) Ames = Beadlea elata (Sw.) Small
elatum Lindl.
longiflorum (Schltr.) Garay
monophyllum (Lindl.) Griseb. 1866 = Cranichis diphylla Sw.
monophyllum Griseb. 1879 = Hapalorchis lineatus (Lindl.) Schltr.
nigricans Schltr. = Beadlea cranichoides (Griseb.) Small
nitidum (Vell.) Schltr.
Richardi Ames = Beadlea elata (Sw.) Small
Schweinfurthianum Garay
sellilabre (Griseb.) Schltr.
tenue Lindl. = Hapalorchis lineatus (Lindl.) Schltr.

Schiedeella Schltr. in Beih. Bot. Centralbl. 37(2): 379, 1920.

Etymology: In honor of Christian Julius Wilhelm Schiede (1798–1836), a German naturalist and plant collector in Mexico.

Sepals similar, subequal, connivent, subcampanulate, parallel, with more or less arcuately spreading apices; dorsal sepal concave, adnate to back of column above base; lateral sepals with an oblique base adnate to short, decurrent column-foot. Petals linear, agglutinate with dorsal sepal. Lip with a distinct, flat claw without thickened margins and with a calliferous or incrassate, auriculate to cordate base and a fleshy, more or less papillose apical part. Column slender, arcuate, somewhat widened towards apex, at base produced in a sharply curved, decurrent foot; stigmata 2, confluent; rostellum from a narrowly cuneate base sinuously linear-triangular, acuminate. Anther ovate-cordate, acute; pollinia clavate with a short, linear-oblong viscidium. Ovary cylindric to fusiform, somewhat twisted.

Terrestrial, slender plants. Roots fasciculate, fleshy tuberous. Leaves either synanthous or hysteranthous, distinctly petiolate. Stem erect, vaginate, terminated by a loosely few- to many-flowered spike. Flowers small to medium, spirally arranged or quaquaversal.

TYPE: *Spiranthes transversalis* Rich. & Gal. [Schlecter in Beih. Bot. Centralbl. 37(2): 382, 1920.]

Six species native to Mexico, Guatemala, Honduras, Costa Rica, and the Greater Antilles.

Index to species

albovaginata (C. Schweinf.) Balogh = Deiregyne albovaginata (C. Schweinf.) Garay
Schiedeella Amesiana Garay, nom. nov.
Basionym: Spiranthes Wrightii Ames, Orchid. 7: 131, 1922, not Schltr. 1913.
chartacea L.O.Wms. ex Balogh = Deiregyne chartacea (L.O.Wms.) Garay
chloreaeformis (Rich. & Gal.) Balogh = Deiregyne diaphana (Lindl.) Garay
congestiflora (L.O.Wms.) Balogh = Funckiella congestiflora (L.O.Wms.) Garay
cobanensis (Schltr.) Schltr. = Kionophyton pyramidalis (Lindl.) Garay
densiflora (C. Schweinf.) Balogh = Dithyridanthus densiflorus (C. Schweinf.) Garay
eriophora (Robins. & Greenm.) Schltr. = Deiregyne eriophora (Robins. & Greenm.) Garay
falcata (L.O.Wms.) Balogh = Deiregyne falcata (L.O.Wms.) Garay
hyemalis (Rich. & Gal.) Balogh = Funckiella hyemalis (Rich. & Gal.) Schltr.
Llaveana (Lindl.) Schltr.
michuacana (Llave & Lex.) Balogh = Stenorrhynchos michuacanum (Llave & Lex.) Lindl.
muscicola (Garay & Dunsterv.) Garay & Dunsterv. = Stalkya muscicola (Garay & Dunsterv.) Garay
Schiedeella Nagelii (L.O.Wms.) Garay, comb. nov.
Basionym: Spiranthes Nagelii L.O.Wms. in Bot. Mus. Leafl. 12: 230, 1946.
obtecta (C.Schweinf.) Balogh = Deiregyne obtecta (C.Schweinf.) Garay
parasitica (Rich. & Gal.) Schltr.
petiolata Schltr. = Schiedeella Llaveana (Lindl.) Schltr.
pseudopyramidalis (L.O.Wms.) Balogh = Deiregyne pseudopyramidalis (L.O.Wms.) Garay
pubicaulis (L.O.Wms.) Balogh = Lyroglossa pubicaulis (L.O.Wms.) Garay
pyramidalis (Lindl.) Schltr. = Kionophyton pyramidalis (Lindl.) Garay
rubrocallosa (Robins. & Greenm.) Balogh = Microthelys rubrocallosum (Robins. & Greenm.) Garay
saltensis (Ames) Schltr. = Deiregyne durangensis (A. & S.) Garay
sparsiflora (C.Schweinf.) Balogh = Physogyne sparsiflora (C. Schweinf.) Garay
stolonifera (Ames & Correll) Balogh = Funckiella stolonifera (Ames & Correll) Garay
tenella (L.O.Wms.) Balogh = Deiregyne tenella (L.O.Wms.) Garay

trilineata (Lindl.) Balogh = Gularia trilineata (Lindl.) Garay
transversalis (Rich. & Gal.) Schltr. = Schiedeella Llaveana (Lindl.) Schltr.
velata (Robins. & Fern.) Schltr. = Deiregyne velata (Robins. & Fern.) Garay

Schiedeella violacea (Rich. & Gal.) Garay, comb. nov.
Basionym: Spiranthes violacea Rich. & Gal. in Ann. Sci. Nat. ser. 3, 3: 32, 1845.

Schiedeella Wercklei (Schltr.) Garay, comb. nov.
Basionym: Spiranthes Wercklei Schltr. in Fedde, Rep. 10: 482, 1911.

Serapias L.
aphylla Vell. = Pelexia Arrabidae (Rchb.f.) Garay
biflora Vell. = Sarcoglottis biflora (Vell.) Schltr.
coccinea Vell. = Sacoila lanceolata (Aubl.) Garay
congesta Vell. = Beadlea congesta (Vell.) Garay
fasciculata Vell. = Sarcoglottis fasciculata (Vell.) Schltr.
Neottia Gmel. = Sacoila lanceolata (Aubl.) Garay
nitida Vell. = Sauroglossum nitidum (Vell.) Schltr.
polyaden Vell. = Stigmatosema polyaden (Vell.) Garay
speciosa (Jacq.) Gmel. = Stenorrhynchos speciosum (Jacq.) L.C.Rich. ex Spreng.
spiralis (L.) Scop. = Spiranthes spiralis (L.) Chevall.
tomentosa Vell. = Sacoila lanceolata (Aubl.) Garay
ventricosa Vell. = Sarcoglottis ventricosa (Vell.) Hoehne

Skeptrostachys Garay, gen. nov.

Etymology: *Skeptron* = baton and *stachys* = spike, in allusion of appearance of the inflorescence in most species.

Sepala dissimilia, conniventia, subparallela, apicibus leviter arcuato-patentibus; sepalo postico valde cucullato, libero; sepalis lateralibus obliquis, pedi columnae decurrentibus. Petala margine interiore sepalo intermedio agglutinata, plus minusve sinuosa, basi decurrentia. Labellum plus minusve sigmoideum, basi conduplicatum, marginibus calloso-incrassatis; lamina recurva, margines in medio utrinque lateribus columnae agglutinatae. Columna brevis, cylindrica, basi in pedem longum, decurrentem producta; stigmata 2, confluentia vel V-formia; rostellum rigidum, acuminatissimum, basi utrinque obscure unidentatum. Anthera cucullata vel umbonata; pollinia clavata, viscidio lineari affixa. Ovarium oblique ovoideum vel fusiforme.

Plantae terrestres, elatae; radicibus fasciculatis, crassiusculis, stipitatis; foliis plerumque basilaribus; sursum in bracteas transeuntibus; caulibus erectis, supra multifloris; rhachide cylindrica, satis densiflora; floribus inter mediocres, haud ringentibus.

Sepals dissimilar, connivent, subparallel, with somewhat arcuately spreading apices; dorsal sepal deeply cucullate, free from column; lateral sepals oblique and decurrent on column-foot. Petals agglutinate with dorsal sepal, more or less sinuous, with a decurrent base. Lip more or less sigmoid with a conduplicate base of which the margins callose-thickened; the main blade is recurved and in middle the margins agglutinate with sides of column. Column short, cylindric, basally produced in a long, decurrent foot; stigmata 2, confluent or V-shaped; rostellum rigid, very sharply pointed and at base on both sides provided rather obscurely with a tooth. Anther cucullate or umbonate; pollinia clavate with a linear viscidium. Ovary obliquely ovoid or fusiform.

Terrestrial, tall plants. Roots fasciculate, fleshy-thickened, stipitate. Leaves mostly basal or near base, decreasing upward into bracts. Stem erect, terminated by a many-flowered, cylindrical, rather densely-flowered spike. Flowers medium in size with hardly ringent sepals.

TYPE: *Spiranthes rupestris* Lindl.

12 species native to Brazil and adjacent countries to south and southeast.

Index to species.

Skeptrostachys Arechavaletanii (Barb.Rodr.) Garay, comb. nov.
Basionym: Stenorrhynchus Arechavaletanii Barb.Rodr. in Contr. Jard.Bot. Rio 4: 99, 1907.

Skeptrostachys balanophorostachya (Rchb.f. & Warm.) Garay, comb. nov.
Basionym: Spiranthes balanophorostachya Rchb.f. & Warm., Otia Bot. Hamb. 2: 54, 1881.

Skeptrostachys Berroana (Krzl.) Garay, comb. nov.
Basionym: Stenorrhynchus Berroanus Krzl. in Svensk Vet. Akad. Handl. 46(10): 26, 1911.

Skeptrostachys congestiflora (Cogn.) Garay, comb. nov.
Basionym: Stenorrhynchus congestiflorus Cogn. in Mart., Fl. Bras. 3(4): 539, 1895.

Skeptrostachys disoides (Krzl.) Garay, comb. nov.
Basionym: Spiranthes disoides Krzl. in Svensk Vet. Akad. Handl. 46(10): 33, 1911.

Skeptrostachys gigantea (Cogn.) Garay, comb. nov.
Basionym: Stenorrhynchus giganteus Cogn. in Mart., Fl. Bras. 3(6): 533, 1906.

Skeptrostachys latipetala (Cogn.) Garay, comb. nov.
Basionym: Stenorrhynchus latipetalus Cogn. in Bull. Soc. Roy. Belg. 43: 286, 1907.
Skeptrostachys montevidensis (Barb.Rodr.) Garay, comb. nov.
Basionym: Stenorrhynchus montevidensis Barb. Rodr. in Contr. Jard. Bot. Rio 4: 98, 1907.
Skeptrostachys paraguayensis (Rchb.f.) Garay, comb. nov.
Basionym: Spiranthes paraguayensis Rchb.f. in Linnaea 25: 230, 1852.
Skeptrostachys paranahybae (Krzl.) Garay, comb. nov.
Basionym: Spiranthes paranahybae Krzl. in Ann. Nat. Hist. Mus. Wien 27: 110, 1913.
Skeptrostachys rupestris (Lindl.) Garay, comb. nov.
Basionym: Spiranthes rupestris Lindl., Gen and Sp. Orch. Pl. 474, 1840.
Skeptrostachys Sancti-Jacobi (Krzl.) Garay, comb. nov.
Basionym: Stenorrhynchus Sancti-Jacobi Krzl. in Fedde, Rep. 6: 22, 1908.

Spiranthes L.C.Rich., Orch. Europ. Annot. 20, 1817, *nom. cons.*
Etymology: *Speira* = coil and *anthos* = flower, in reference to the spirally twisted inflorescence of the plants originally assigned to the genus.
Syn.: *Orchiastrum* Seguier, Pl. Veron. Suppl. 252, 1754.
Type: *Ophrys spiralis* L.
Aristotelea Lour., Fl. Cochinch. 2: 522, 1790, not L'Herit. 1784.
Type: *Aristotelea spiralis* Lour.
Tussacia Raf. ex Desv., Obs. Pl. Environ. Angers 91, 1818, not *Tussaca* Raf.
Lectotype: *Ophrys spiralis* L. *in hoc loco.*
Monustes Raf., Fl. Tellur 2: 87, 1837.
Type: *Neottia australis* R. Br.
Gyrostachys Pers. ex Bl., Coll. Orch. 127, 1859.
Lectotype: *Ophrys spiralis* L. *in hoc loco*
Ibidium Salisb. ex Small, Fl. SE United States, ed. 2, 318, 1913.
Lectotype: *Ophrys spiralis* L. [House in Bull. Torr. Bot. Cl. 32: 380, 1905]
Triorchis Petiver ex Nieuwl. in Amer. Midl. Nat. 3: 122, 1913.
Type: Ophrys spiralis L. [Petiver, Opera 2: Ray's English Herb. and Cat., t. 68, f.7, 1764]

Sepals rather similar, free, connivent, with somewhat arcuately spreading apices; dorsal sepal concave to cucullate; lateral sepals oblique, but without a decurrent base. Petals agglutinate with dorsal sepal, oblique at base. Lip fleshy, broadly unguiculate, concave to conduplicate, recurved at more or less undulate-crispate apex, basally provided on each side of the claw with a marginal or intramarginal, more or less conical, falcate callus, the sides agglutinate with sides of column. Column relatively short, cylindric, arcuately expanded upwards, basally produced in a short, incurved foot; stigmata 2, confluent, bilobed; rostellum divided into two distinct, sharply pointed or filiform segments. Anther cordate, acute to obtuse, rather deeply concave; pollinia clavate with linear-oblong viscidium. Ovary sessile, cylindric to fusiform, twisted.

Terrestrial, slender plants. Roots fasciculate, tuberous or fusiform, fleshy. Leaves synanthous or proteranthous, commonly basal or near to base, rarely cauline. Scape slender, erect, vaginate, terminated by a loosely- to densely-flowered inflorescence which is arranged in a single or double spiral. Flowers rather small.

LECTOTYPE: *Ophrys spiralis* L. [Greene, Prop. Brit. Bot. 100, 1929]

42 species native mostly to the temperate regions of North America and Eurasia with representatives in Australia, New Caledonia and New Zealand; a few species are native to the tropical and subtropical regions of Central America, West Indies, northern part of South America, as well as various regions of Malaysia, from Malaya to New Guinea.

Index to species

abyssinica Hochst. ex A. Rich. = Deroemera squamata Rchb.f.
acaulis (J.E.Sm.) Cogn. = Sarcoglottis acaulis (J.E.Sm.) Schltr.
actinosophila Barb.Rodr. = Eurystyles actinosophila (Barb.Rodr.) Schltr.
acutata Rchb.f. & Warm. = Sarcoglottis acutata (Rchb.f. & Warm.) Garay
adnata (Sw.) Benth. ex Fawc. = Pelexia adnata (Sw.) Spreng.
aestivalis Oakes = Spiranthes lucida (H.H. Eaton) Ames
aestivalis (Poir.) L.C.Rich.
affinis C. Schweinf. = Mesadenus affinis (C. Schweinf.) Garay
africana Lindl. = Benthamia spiralis (Thou.) A. Rich.

aguacatensis Rchb.f. = Brachystele guayanensis (Lindl.) Schltr.
albescens Barb.Rodr. = Pteroglossa macrantha (Rchb.f.) Schltr.
albovaginata C. Schweinf. = Deiregyne albovaginata (C. Schweinf.) Garay
alexandrae Krzl. = Beadlea alexandrae (Krzl.) Garay
Allemanii (Barb.Rodr.) Cogn. = Sarcoglottis acaulis (J.E.Sm.) Schltr.
alpestris Barb.Rodr. = Beadlea congesta (Vell.) Garay
amabilis Ames = Hapalorchis lineatus (Lindl.) Schltr.
amblysepala Krzl. = Beadlea diversifolia (Cogn.) Garay
Amesiana Schltr. = Spiranthes torta (Thunb.) Garay & Sweet
amoena (Bieb.) Spreng.
angustilabris J.J.Sm.
annua Lesq. = Spiranthes cernua (L.) L.C.Rich.
aphylla (Ridl.) Cogn. 1895 = Sarcoglottis aphylla (Ridl.) Schltr.
aphyllus (Hook.) Krzl. = Sacoila lanceolata (Aubl.) Garay
apiculata Lindl. = Spiranthes torta (Thunb.) Garay & Sweet
aprica Lindl. = Beadlea aprica (Lindl.) Garay
Arechavaletae Krzl. = Brachystele Arechavaletae (Krzl.) Schltr.
argyrifolia Barb.Rodr. = Beadlea argyrifolia (Barb.Rodr.) Garay
Aristotelia (Raeusch) Merrill = Spiranthes sinensis (Pers.) Ames
Arrabidae Warm. = Pelexia Arrabidae (Rchb.f. & Warm.) Garay
Arseniana Krzl. = Pelexia Schaffneri (Rchb.f.) Schltr.
assurgens Rchb.f. = Sarcoglottis assurgens (Rchb.f.) Schltr.
atramentaria Krzl. = Brachystele Widgrenii (Rchb.f.) Schltr.
atroviridis (Barb.Rodr.) Cogn. = Mesadenella atroviridis (Barb.Rodr.) Garay
aurantiaca (Llave & Lex.) Hemsl. = Stenorrhynchos aurantiacum (Llave & Lex.) Lindl.
australis (R.Br.) Lindl. = Spiranthes sinensis (Pers.) Ames
australis Wight = Spiranthes sinensis (Pers.) Ames
autumnalis (Balb.) L.C.Rich = Spiranthes spiralis (L.) Chevall.
balanophorostachya Rchb.f. & Warm. = Skeptrostachys balanophorostachya (Rchb.f. & Warm.) Garay
Bangii Rolfe = Odontorrhynchus chlorops (Rchb.f.) Garay
Barrancae Esposto = Pelexia Pavonii (Rchb.f.) Garay
Beckii Lindl. = Spiranthes lacera (Raf.) Raf.
bicaudata Ames = Beloglottis bicaudata (Ames) Garay
bicolor Griseb. = Lyroglossa Grisebachii (Cogn.) Schltr.
bicolor (Ker-Gawl.) Lindl. = Beadlea bicolor (Ker-Gawl.) Garay
bicolor Raf. = Spiranthes sinensis (Pers.) Ames
bifida Ridl. = Helonoma bifida (Ridl.) Garay
biflora (Vell.) Cogn. = Sarcoglottis biflora (Vell.) Schltr.
bonariensis Lindl. = Pelexia bonariensis (Lindl.) Schltr.
bracteolaris Krzl. = Stenorrhynchos michuacanum (Llave & Lex.) Lindl.
bracteosa Lindl. = Brachystele bracteosa (Lindl.) Schltr.
bracteosa (A. & S.) L.O.Wms. = Coccineorchis bracteosa (A. & S.) Garay
Brenesii Schltr. = Brachystele guayanensis (Lindl.) Schltr.
brevicaulis Raf. = *incerta sedis*
brevifolia Chapm. = Spiranthes longilabris Lindl.
brevilabris Lindl.
butantanensis Hoehne = Sarcoglottis neuroptera (Rchb.f. & Warm.) Schltr.

calcarata (Sw.) Jiménez = Eltroplectris calcarata (Sw.) Garay & Sweet
callifera C. Schweinf. = Pelexia callifera (C. Schweinf.) Garay
calophylla Barb.Rodr. = Beadlea calophylla (Barb.Rodr.) Garay
camporum Lindl. = Brachystele camporum (Lindl.) Schltr.
camposnovensis Hoehne = Sarcoglottis simplex (Griseb.) Schltr.
Canterae Barb.Rodr. = Skeptrostachys balanophorostachya (Rchb.f. & Warm.) Garay
Casei Catling & Cruise
Castillonii (Haum.) L.O.Wms. = Odontorrhynchus Castillonii (Haum.) Correa
ceracifolia Barb.Rodr. = Lankesterella ceracifolia (Barb.Rodr.) Mansf.
cerina Lindl. = Pelexia cerina (Lindl.) Garay
cernua (L.) L.C.Rich.
chartacea L.O.Wms. = Deiregyne chartacea (L.O.Wms.) Garay
cheirostyloides (Schltr.) C. Schweinf. = Hapalorchis cheirostyloides Schltr.
Chiangii Johnst. = Mesadenus Chiangii (Johnst.) Garay
chilensis A. Rich = Odontorrhynchus chilensis (A.Rich.) Garay
chloreaeformis Rich. & Gal. = Deiregyne diaphana (Lindl.) Garay
chloroleuca Barb. Rodr. = Stigmatosema polyaden (Vell.) Garay
chlorops Rchb.f. = Odontorrhynchus chlorops (Rchb.f.) Garay
cinnabarina (Llave & Lex.) Hemsl. = Dichromanthus cinnabarinus (Llave & Lex.) Garay
cobanensis Schltr. = Kionophyton pyramidalis (Lindl.) Garay
coccinea Garay = Coccineorchis cernua (Lindl.) Garay
Cogniauxiana Barb.Rodr. = Sarcoglottis Cogniauxiana (Barb.Rodr.) Schltr.
colorans N.E.Br. ex Hemsl. = Stenorrhynchos speciosum (Jacq.) L.C.Rich. ex Spreng.
colorata N.E.Br. = Stenorrhynchos speciosum (Jacq.) L.C. Rich ex Spreng.
colorata (Bl.) Hassk. = Goodyera colorata Bl.
comosa Rchb.f. = Beadlea comosa (Rchb.f.) Hamer & Garay
congesta Lindl.
congestiflora L.O.Wms. = Funckiella congestiflora (L.O.Wms.) Garay
constricta (Small) Schumann = Spiranthes odorata (Nutt.) Lindl.
cordatiloba C. Schweinf. = Sarcoglottis neuroptera (Rchb.f. & Warm.) Schltr.
corymbosa Krzl. = Coccineorchis cernua (Lindl.) Garay
costaricensis Rchb.f. = Beloglottis costaricensis (Rchb.f.) Schltr.
cranichoides (Griseb.) Cogn. = Beadlea cranichoides (Griseb.) Small
crispata (Bl.) Zoll. & Morr. = Spiranthes sinensis (Pers.) Ames
cuculligera Rchb.f. & Warm. = Pelexia cuculligera (Rchb.f. & Warm.) Schltr.
curvicalcarata C. Schweinf. = Pelexia laxa (Poepp. & Endl.) Lindl.
cuspidata Lindl. = Mesadenella cuspidata (Lindl.) Garay
cyclochila Krzl. = Brachystele cyclochila (Krzl.) Schltr.
cylindrica Lindl. apud Schltr. = Kionophyton pyramidalis (Lindl.) Garay
decipiens Hook. = Goodyera oblongifolia Raf.
decora Garay = Pelexia decora (Garay) Garay
delicatula Krzl. = Brachystele delicatula (Krzl.) Schltr.

dendroneura Sheviak & Bye = Deiregyne dendroneura (Sheviak & Bye) Garay
densa A. Rich. = Spiranthes Wightiana Lindl.
densiflora C. Schweinf. = Dithyridanthus densiflorus (C. Schweinf.) Garay
diaphana Lindl. = Deiregyne diaphana (Lindl.) Garay
dilatata Lindl. = Brachystele dilatata (Lindl.) Schltr.
disoides Krzl. = Skeptrostachys disoides (Krzl.) Garay
diuretica (Willd.) Lindl. = Brachystele unilateralis (Poir.) Schltr.
diversifolia Cogn. = Beadlea diversifolia (Cogn.) Garay
durangensis A. & S. = Deiregyne durangensis (A. & S.) Garay
ecallosa A. & S. = Beloglottis ecallosa (A. & S.) Hamer & Garay
Ekmanii (Krzl.) Haum. = Pelexia Ekmanii (Krzl.) Schltr.
elata (Sw.) L.C.Rich. = Beadlea elata (Sw.) Small
eldorado Linden & Rchb.f. = Beadlea eldorado (Linden & Rchb.f.) Garay
Emiliae Johnst. = Pelexia Schaffneri (Rchb.f.) Schltr.
ensifolia Rchb.f. = Spiranthes vernalis Engelm. & Gray
epiphyta Barb.Rodr. = Lankesterella caespitosa (Lindl.) Hoehne
epiphytica Schltr. = Beadlea Prasophyllum (Rchb.f.) Hamer & Garay
eriophora Robins. & Greenm. = Funckiella eriophora (Robins. & Greenm.) Garay
esmeralda Linden & Rchb.f. = Mesadenella cuspidata (Lindl.) Garay
Eugenii Rchb.f. & Warm. = Beadlea Eugenii (Rchb.f. & Warm.) Garay
euglossa Krzl. = Lyroglossa Grisebachii (Cogn.) Schltr.
euphlebia Rchb.f. = Pteroglossa euphlebia (Rchb.f.) Garay
excelsa Krzl. = Sauroglossum nitidum (Vell.) Schltr.
exigua Rolfe = Hetaeria exigua (Rolfe) Schltr.
falcata L.O.Wms. = Deiregyne falcata (L.O.Wms.) Garay
fasciculata (Vell.) Cogn. = Sarcoglottis fasciculata (Vell.) Schltr.
fauci-sanguinea Dod = Schiedeella parasitica (Rich. & Gal.) Schltr.
Fawcettii Cogn. = Hapalorchis lineatus (Lindl.) Schltr.
flexuosa (J.E.Sm.) Lindl. 1824 = Spiranthes sinensis (Pers.) Ames
flexuosa (J.E.Sm.) Raf. 1837 = Spiranthes sinensis (Pers.) Ames
flexuosa Raf. 1833 = *incerta sedis*
floridana (Wherry) Cory
Funckiana Rich. & Gal. = Pelexia Funckiana (Rich. & Gal.) Schltr.
Galeottiana Rich. & Gal. = Mesadenus polyanthus (Rchb.f.) Schltr.
Gardneri Lindl. ex Gardn. = Eurystyles Gardneri (Lindl. ex Gardn.) Garay
gemmipara (J.E.Sm.) Lindl. = Spiranthes Romanzoffiana Cham.
glabrescens Hashimoto = Beadlea glabrescens (Hashimoto) Garay
glauca Raf. = Spiranthes spiralis (L.) Chevall.
goninensis (Pulle) C. Schweinf. = Pelexia goninensis (Pulle) Schltr.
Gonzalesii L.O.Wms. = Physogyne Gonzalesii (L.O.Wms) Garay
goodyeroides Schltr. = Beadlea goodyeroides (Schltr.) Garay
goyazensis Cogn. = Pelexia goyazensis (Cogn.) Garay
gracilis (Bigel.) Beck = Spiranthes lacera (Raf.) Raf.
gracilis (Bl.) Hassk. 1844 = Chlorosa gracilis Bl.
graminea Lindl.
grandiflora Lindl. = Sarcoglottis grandiflora (Lindl.) Kl.
grandis (Bl.) Hassk. = Goodyera grandis (Bl.) Bl.

Grayi Ames = Spiranthes tuberosa Raf.
Grisebachii Cogn. = Lyroglossa Grisebachii (Cogn.) Schltr.
gutturosa Rchb.f. = Pelexia gutturosa (Rchb.f.) Garay
guayanensis (Lindl.) Cogn. = Brachystele guayanensis (Lindl.) Schltr.
hamata (Schltr.) C. Schweinf. = Pelexia hamata Schltr.
Hassleri Cogn. = Sarcoglottis Hassleri (Cogn.) Schltr.
hemichrea Lindl. = Aulosepalum hemichrea (Lindl.) Garay
hirta Lindl. = Pelexia hirta (Lindl.) Schltr.
homalogastra Rchb.f. & Warm. = Sarcoglottis homalogastra (Rchb.f. & Warm.) Schltr.
hondurensis Schltr. = Gularia trilineata (Lindl.) Garay
hongkongensis S.Y.Hu & Barretta
Hostmannii Rchb.f. ex Griseb. = Brachystele guayanensis (Lindl.) Schltr.
hyemalis Rich & Gal. = Funckiella hyemalis (Rich. & Gal.) Schltr.
hypnophila Barb.Rodr. = Pelexia novofriburgensis (Rchb.f.) Garay
hysterantha Barb.Rodr. = Pelexia hysterantha (Barb.Rodr.) Schltr.
icmadophila Barb.Rodr. = *incerta sedis*
inaequilatera Poepp. & Endl. = Beadlea inaequilatera (Poepp. & Endl.) Garay
indica Lindl. ex Steud. = Spiranthes sinensis (Pers.) Ames
X intermedia Ames
itararensis Krzl. = Sarcoglottis itararensis (Krzl.) Hoehne
itatiaiensis Krzl. = Beadlea itatiaiensis (Krzl.) Garay
jaliscana Watson = Sacoila lanceolata (Aubl.) Garay
lacera (Raf.) Raf.
laciniata (Small) Ames
lancea (Thunb.) Back., Bakh. & van Steen. = Herminium lanceum (Thunb.) Vuijk
lanceolata (Aubl.) Leon = Sacoila lanceolata (Aubl.) Garay
Lankesteri Standl. & L.O.Wms. = Hapalorchis pumilis (C. Schweinf.) Garay
lanuginosa Rich. & Gal. = Stenorrhynchos aurantiacum (Llave & Lex.) Lindl.
latifolia Rich. & Gal. 1845 = Pelexia Richardiana (Schltr.) Garay
latifolia Torr. ex Lindl. 1840 = Spiranthes lucida (H.H.Eaton) Ames
laxa (Poepp. & Endl.) C. Schweinf. = Pelexia laxa (Poepp. & Endl.) Lindl.
laxiflora (Ekman & Mansf.) Jiménez = Beadlea laxiflora (Ekman & Mansf.) Garay
laxiflora Raf. 1837 = Spiranthes torta (Thunb.) Garay & Sweet
Lechleri (Schltr.) C. Schweinf. = Brachystele unilateralis (Poir.) Schltr.
leucosticta Rchb.f. = Pelexia novofriburgensis (Rchb.f.) Garay
Lindleyana Link, Kl. & Otto = Beadlea Lindleyana (Link, Kl. & Otto) Garay & Dunsterv.
Lindmaniana Krzl. = Sarcoglottis neuroptera (Rchb.f. & Warm.) Schltr.
lineata Lindl. = Hapalorchis lineatus (Lindl.) Schltr.
lithophila Barb.Rodr. = Sarcoglottis biflora (Vell.) Schltr.
Llaveana Lindl. = Schiedeella Llaveana (Lindl.) Schltr.
lobata Lindl. = Pelexia lobata (Lindl.) Garay
longiauriculata C. Schweinf. = Sarcoglottis simplex (Griseb.) Schltr.

longibracteata Barb.Rodr. = Beadlea longibracteata (Barb.Rodr.) Garay
longifolia (Bl.) Hassk. = Lepidogyne longifolia (Bl.) Bl.
longilabris Lindl.
longipetiolata Rchb.f. = Pelexia laxa (Poepp. & Endl.) Lindl.
longispicata A. Rich. = Spiranthes sinensis (Pers.) Ames
lucayana (Britt.) Cogn. = Mesadenus lucayanus (Britt.) Schltr.
lucida (H.H.Eaton) Ames
lupulina (Lindl.) Hemsl. = Stenorrhynchos aurantiacum (Llave & Lex.) Lindl.
luteo-alba Rich. & Gal. = Beadlea luteo-alba (Rich. & Gal.) Garay
Lutzii (Pabst) Jones = Cotylolabium Lutzii (Pabst) Garay
macrantha Rchb.f. = Pteroglossa macrantha (Rchb.f.) Schltr.
macrophylla (Don) Spreng. = Herminium macrophyllum (Don) Dandy
macropoda Barb.Rodr. = Pelexia macropoda (Barb.Rodr.) Schltr.
marcostachya Poepp. & Endl. = Stenoptera macrostachya (Poepp. & Endl.) Rchb.f.
maculata (Rolfe) C. Schweinf. = Pelexia laxa (Poepp. & Endl.) Lindl.
madrensis (Rchb.f.) Hemsl. = Stenorrhynchos michuacanum (Llave & Lex.) Lindl.
magnicamporum Sheviak
Madonii Rchb.f. = Pelexia Mandonii (Rchb.f.) Schltr.
margaritifera Linden & Rchb.f. = Mesadenella margaritifera (Linden & Rchb.f.) Garay
matucanensis Krzl. = Pelexia matucanensis (Krzl.) Schltr.
metallica Rolfe = Sarcoglottis metallica (Rolfe) Schltr.
michuacana (Llave & Lex.) Hemsl. = Stenorrhynchos michuacanum (Llave & Lex.) Lindl.
micrantha Barb.Rodr. = Hapalorchis micranthus (Barb.Rodr.) Hoehne
Millei Schltr. = Beadlea Millei (Schltr.) Garay
minutiflora Rchb.f. = Beadlea peruviana (Presl) Garay
minutiflora Rich. & Gal. = Microthelys minutiflora (Rich. & Gal.) Garay
misera Krzl. = Sarcoglottis misera (Krzl.) Pabst
monophylla (Lindl.) Cogn. = Cranichis diphylla Sw.
monophylla (Don) Spreng. = Herminium monophyllum (Don) Hunt & Summerh.
montana Raf. 1833 = ?Spiranthes ovalis Lindl.
montana Rich. & Gal. 1845 = Dichromanthus cinnabarinus (Llave & Lex.) Garay
montana (Lindl.) Hemsl. 1884 = Dichromanthus cinnabarinus (Llave & Lex.) Garay
multiflora Barb.Rodr. ex Jackson = Skeptrostachys balanophorostachya (Rchb.f. & Warm.) Garay
muscicola Garay & Dunsterv. = Stalkya muscicola (Garay & Dunsterv.) Garay
Nagelii L.O.Wms. = Schiedeella Nagelii (L.O.Wms.) Garay
navarrensis (Ames) L.O.Wms. = Coccineorchis navarrensis (Ames) Garay
neglecta Ames = Spiranthes vernalis Engelm. & Gray
Nelsonii Greenm. = Aulosepalum Nelsonii (Greenm.) Garay
neo-caledonica Schltr.

neottiorhiza Krzl. = Pelexia neottiorhiza (Krzl.) Pabst
neuroptera Rchb.f. & Warm. = Sarcoglottis neuroptera (Rchb.f. & Warm.) Schltr.
nitida (Vell.) Cogn. = Sauroglossum nitidum (Vell.) Schltr.
Novae-Zelandiae Hook.f. = Spiranthes sinensis (Pers.) Ames
novofriburgensis (Rchb.f.) Rchb.f. = Pelexia novofriburgensis (Rchb.f.) Garay
Nuil L.C.Rich. = Brachystele unilateralis (Poir.) Schltr.
nutans (Kunth & Bouche) Garay & Dunsterv. = Stenorrhynchos nutans Kunth & Bouche
nutantiflora Schltr. = Microthelys nutantiflora (Schltr.) Garay
oaxacana Robins. & Greenm. = Deiregyne diaphana (Lindl.) Garay
obliqua J.J.Sm. = Pelexia obliqua (J.J.Sm.) Garay
obtecta C. Schweinf. = Deiregyne obtecta (C. Schweinf.) Garay
obtusa Schltr. = Aulosepalum Nelsonii (Greenm.) Garay
ochracea Rich. & Gal. = Sarcoglottis rosulata (Lindl.) P.N.Don
ochroleuca (Rydb.) Rydb.
odorata (Nutt.) Lindl.
oestivalis Boiss. Sphalm. = Spiranthes aestivalis (Poir.) L.C.Rich.
oestrifera Rchb.f. & Warm. = Pelexia oestrifera (Rchb.f. & Warm.) Schltr.
oligantha Hoehne = Beadlea oligantha (Hoehne) Garay
olivacea Rolfe = Beadlea olivacea (Rolfe) Garay
orchioides (Sw.) A. Rich. = Sacoila lanceolata (Aubl.) Garay
ornithocephala (Barb.Rodr.) Jackson = Sarcoglottis fasciculata (Vell.) Schltr.
orthantha Krzl. = Lankesterella orthantha (Krzl.) Garay
orthosepala Rchb.f. & Warm. = Pelexia orthosepala (Rchb.f. & Warm.) Schltr.
ovalis Lindl.
pachychila Krzl. = Sauroglossum nitidum (Vell.) Schltr.
pachyrhiza Krzl. = Pelexia matucanensis (Krzl.) Schltr.
paludosa Cogn. = Beadlea aprica (Lindl.) Garay
Pamii Braid = Beadlea Lindleyana (Link, Kl. & Otto) Garay & Dunsterv.
papuana Schltr.
paraguayensis Rchb.f. = Skeptrostachys paraguayensis (Rchb.f.) Garay
paranahybae Krzl. = Skeptrostachys paranahybae (Krzl.) Garay
parasitica Rich. & Gal. = Schiedeella parasitica (Rich. & Gal.) Schltr.
Parksii Correll
parviflora (Chapm.) Ames = Spiranthes ovalis Lindl.
parviflora (Bl.) Hassk. 1844 = Goodyera parviflora (Bl.) Bl.
parviflora (J.E.Sm.) Lindl. 1824 = Spiranthes sinensis (Pers.) Ames
parviflora (J.E.Sm.) Raf. 1837 = Spiranthes sinensis (Pers.) Ames
pauciflora Raf. 1833 = *incerta sedis*
pauciflora Rich. & Gal. 1845 = Sarcoglottis corymbosa Garay
pauciflora (Rchb.f.) Hemsl. 1884 = Funckiella hyemalis (Rich. & Gal.) Schltr.
Pavonii Rchb.f. = Pelexia Pavonii (Rchb.f.) Garay
pedicellata Cogn. = Brachystele pedicellata (Cogn.) Garay
peruviana Presl = Beadlea peruviana (Presl) Garay

petenensis L.O.Wms. = Mesadenella petenensis (L.O.Wms.) Garay
petiolaris Raf. = *incerta sedis*
Petola (Bl.) Hassk. = Macodes Petola (Bl.) Lindl.
picta (R.Br.) Lindl. = Sarcoglottis acaulis (J.E.Sm.) Schltr.
plantaginea (Raf.) Raf. = Spiralis lucida (H.H.Eaton) Ames
plantaginea Lindl. 1840 = Beadlea plantaginea Garay
plantaginea (Don) Spreng. 1826 = Malaxis latifolia J.E.Sm.
plantaginea Torr. 1843 = Spiranthes lucida (H.H.Eaton) Ames
polyantha Rchb.f. = Mesadenus polyanthus (Rchb.f.) Schltr.
porphyricola Schltr. = Microthelys rubrocallosa (Robins. & Greenm.) Garay
porrifolia Lindl.
praecox (Walt.) Wats.
Prasophyllum Rchb.f. = Beadlea Prasophyllum (Rchb.f.) Hamer & Garay
Preslii Lindl. = Cyclopogon ovalifolium Presl
Pringlei Wats. = Beadlea saccata (Rich. & Gal.) Garay
pseudogoodyerioides L.O.Wms. = Pseudogoodyera Wrightii (Rchb.f.) Schltr.
pseudopyramidalis L.O.Wms. = Deiregyne pseudopyramidalis (L.O.Wms.) Garay
pterygantha Rchb.f. & Warm. = Pelexia pterygantha (Rchb.f. & Warm.) Schltr.
pubens Rich. & Gal. = Stenorrhynchos pubens (Rich. & Gal.) Schltr.
pubescens Barb.Rodr. = Beadlea bicolor (Ker-Gawl.) Garay
pubicaulis L.O.Wms. = Lyroglossa pubicaulis (L.O.Wms.) Garay
pudica Lindl. = Spiranthes sinensis (Pers.) Ames
pulchra Schltr. = Aulosepalum hemichrea (Lindl.) Garay
pumila C. Schweinf. = Hapalorchis pumilus (C. Schweinf.) Garay
pusilla Miq.
pyramidalis Lindl. = Kionophyton pyramidalis (Lindl.) Garay
quadridentata (Willd.) Lindl. = Spiranthes torta (Thunb.) Garay & Sweet
quinquelobata (Poir) Urb. = Spiranthes torta (Thunb.) Garay & Sweet
ramentacea Lindl. = Aulosepalum ramentaceum (Lindl.) Garay
Reichenbachiana Garay & Dunsterv. = Beadlea peruviana (Presl) Garay
Reverchonii (Small) Schumann = Spiranthes vernalis Engelm. & Gray
Richardi Autr. & Durand = Stenorrhynchos speciosum (Jacq.) L.C.Rich. ex Spreng.
Richardiana Schltr. = Pelexia Richardiana (Schltr.) Garay
Rimbachii (Schltr.) C. Schweinf. = Beadlea Rimbachii (Schltr.) Garay
Rodriguesii Cogn. = Beadlea longibracteata (Barb.Rodr.) Garay
Romanzoffiana Cham.
rosulata Lindl. = Sarcoglottis rosulata (Lindl.) P.N.Don
rotundifolia Cogn. = Discyphus scopulariae (Rchb.f.) Schltr.
rubrocallosa Robins. & Greenm. = Microthelys rubrocallosa (Robins. & Greenm.) Garay
rufescens Fisch. ex Kl. = Sarcoglottis ventricosa (Vell.) Hoehne
rupestris Lindl. 1840 = Skeptrostachys rupestris (Lindl.) Garay
rupestris Barb.Rodr. 1877 = Sarcoglottis rupicola Garay
saccata Rich. & Gal. = Beadlea saccata (Rich. & Gal.) Garay

sagittata Rchb.f. & Warm. = Sarcoglottis sagittata (Rchb.f. & Warm.) Schltr.
saltensis Ames = Deiregyne durangensis (A. & S.) Garay
saltensis Griseb. = Pelexia saltensis (Griseb.) Schltr.
sancta Rchb.f. & Warm. = Pelexia sancta (Rchb.f. & Warm.) Garay
sarcoglossa Rich. & Gal. = Galeottiella sarcoglossa (Rich. & Gal.) Schltr.
Sauroglossum Nichols = Sauroglossum elatum Lindl.
Sawyeri Standl. & L.O.Wms. = Kionophyton Sawyeri (Standl. & L.O. Wms.) Garay
sceptrodes Rchb.f. = Sarcoglottis sceptrodes (Rchb.f.) Schltr.
Schaffneri Rchb.f. = Pelexia Schaffneri (Rchb.f.) Schltr.
Schwackei Cogn. = Sarcoglottis Schwackei (Cogn.) Schltr.
scopulariae Rchb.f. = Discyphus scopulariae (Rchb.f.) Schltr.
sellilabris Griseb. = Sauroglossum sellilabre (Griseb.) Schltr.
seminuda Schltr. = Kionophyton seminuda (Schltr.) Garay
sibirica Raf. = Spiranthes aestivalis (Poir.) L.C.Rich.
simplex Gray 1867 = Spiranthes tuberosa Raf.
simplex Griseb. 1864 = Sarcoglottis simplex (Griseb.) Schltr.
sincorensis Schltr. = Sarcoglottis sincorensis (Schltr.) Schltr.
sinensis (Pers.) Ames
Smallii Schltr. = Spiranthes ovalis Lindl.
Smithii Rchb.f. = Pelexia Smithii (Rchb.f.) Garay
sparsiflora C. Schweinf. = Physogyne sparsiflora (C. Schweinf.) Garay
speciosa (Presl) Lindl. = Sarcoglottis acaulis (J.E.Sm.) Schltr.
speciosa (Jacq.) A.Rich. = Stenorrhynchos speciosum (Jacq.) L.C.Rich. ex Spreng.
spiralis (L.) Chevall.
spiralis (Lour.) Makino = Spiranthes sinensis (Pers.) Ames
spiranthoides (Schltr.) Garay & Dunsterv. = Beadlea peruviana (Presl) Garay
spirata Hoehne = Lyroglossa spirata (Hoehne) Garay
squamulosa (H.B.K.) Leon = Sacoila squamulosa (H.B.K.) Garay
Stahlii Cogn. = Mesadenus Stahlii (Cogn.) Garay
Standleyi (Ames) L.O.Wms. = Coccineorchis Standleyi (Ames) Garay
X Steigeri Correll
stenorrhynchoides (Griseb.) Leon = Pelexia adnata (Sw.) Spreng.
stolonifera Ames & Correll = Funckiella stolonifera (Ames & Correll) Garay
Storeri Chapm. = Beadlea cranichoides (Griseb.) Small
strateumatica (L.) Lindl. = Zeuxine strateumatica (L.) Schltr.
stricta (Rydb.) A. Nels. = Spiranthes Romanzoffiana Cham.
stricta (Rydb.) Wilm. = Spiranthes Romanzoffiana Cham.
stylites Lindl.
subfiliformis Cogn. = Brachystele subfiliformis (Cogn.) Schltr.
subpandurata A. & S. = Beloglottis subpandurata (A. & S.) Garay
subumbellata C. Schweinf. = Sauroglossum corymbosum (Lindl.) Garay
suishanensis (Hayata) Schltr.
sulphurea (Llave & Lex.) Hemsl. = Stenorrhynchos michuacanum (Llave & Lex.) Lindl.

Swartzii Krause = Spiranthes torta (Thunb.) Garay & Sweet
tenella L.O.Wms. = Deiregyne tenella (L.O.Wms.) Garay
tenuiflora Greenm. = Aulosepalum tenuiflorum (Greenm.) Garay
tenuis Lindl.
tenuis (Lindl.) Benth. ex Fawc. = Hapalorchis lineatus (Lindl.) Schltr.
tenuissima L.O.Wms. = Mesadenus tenuissimus (L.O.Wms.) Garay
Thelymitra Rchb.f. = Gularis trilineata (Lindl.) Garay
Tonduzii Schltr. = Mesadenella Tonduzii (Schltr.) Pabst & Garay
torta (Thunb.) Garay & Sweet
tortilis (Sw.) L.C.Rich. = Spiranthes torta (Thunb.) Garay & Sweet
tortilis Beck = Spiranthes lacera (Raf.) Raf.
tortilis Chapm. = Spiranthes praecox (Walt.) Wats.
tortilis Darlington = Spiranthes vernalis Engelm. & Gray
tortilis Torr. = Spiranthes vernalis Engelm. & Gray
tovarensis Garay & Dunsterv. = Pelexia tovarensis (Garay & Dunsterv.) Garay & Dunsterv.
trachyglossa Krzl. = Pelexia cuculligera (Rchb.f. & Warm.) Schltr.
transversalis Rich. & Gal. = Schiedeella Llaveana (Lindl.) Schltr.
trilineata Lindl. = Gularia trilineata (Lindl.) Garay
trilineata var. crenulata L.O.Wms. = Gularia crenulata (L.O.Wms.) Garay
triloba (Small) Schumann = Spiranthes odorata (Nutt.) Lindl.
truncata Lindl. = Beadlea truncata (Lindl.) Garay
tuberosa Raf.
Tuerckheimii Schltr. = Schiedeella Llaveana (Lindl.) Schltr.
Ulaei Cogn. = Brachystele Ulaei (Cogn.) Schltr.
uliginosa Barb.Rodr. = Sarcoglottis uliginosa Barb.Rodr.
umbraticola L.O.Wms. = Mesadenella petenensis (L.O.Wms.) Garay
umbrossa Barb.Rodr. = Sarcoglottis umbrosa (Barb.Rodr.) Schltr.
unalascensis Spreng. = Piperia unalascensis (Spreng.) Rydb.
vaginata (H.B.K.) Lindl. ex Jackson = Stenorrhynchos vaginatum (H.B.K.) Spreng.
Valerioi A. & S. = Schiedeella parasitica (Rich. & Gal.) Schltr.
valida (Ames) L.O.Wms. = Pelexia Smithii (Rchb.f.) Garay
variegata (Barb.Rodr.) Cogn. = Beadlea variegata (Barb.Rodr.) Garay
variegata Krzl. = Beadlea olivacea (Rolfe) Garay
velata Robins. & Fern. = Deiregyne velata (Robins. & Fern.) Garay
vernalis Engelm. & Gray
villosa Poepp. & Endl. = Sarcoglottis villosa (Poepp. & Endl.) Schltr.
violacea Rich. & Gal. = Schiedeella violacea (Rich. & Gal.) Garay
viridiflora (Makino) Makino = Spiranthes sinensis (Pers.) Ames
Warmingii Rchb.f. = Beadlea Warmingii (Rchb.f.) Garay
Weberbaueri Krzl. = Pelexia Weberbaueri (Krzl.) Schltr.
Weirii Rchb.f. = Pelexia laxa (Poepp. & Endl.) Lindl.
Wendlandiana (Krzl.) Garay = Pelexia olivacea Rolfe
Wercklei Schltr. = Schiedeella Wercklei (Schltr.) Garay
Wightiana Lindl.
Woodsonii L.O.Wms. = Sarcoglottis Woodsonii (L.O.Wms.) Garay
Wrightii Ames 1922 = Schiedeella Amesiana Garay

Wrightii (Rchb.f.) Schltr. 1913 = Pseudogoodyera Wrightii (Rchb.f.) Schltr.
yungasensis Rolfe = Pelexia yungasensis (Rolfe) Schltr.
X Zahlbruckneri Fleischm.

Stalkya Garay, gen nov.

Etymology: In honor of Galfrid Clement Keyworth Dunsterville (1905–), friend and colleague, formerly a British career businessman, but also an avid student of Venezuelan orchids, who by his friends and orchidophiles alike is affectionately called "Stalky", a name coined by his former classmates in college.

Sepala similia, parallela, conniventia, libera; sepalo postico concavo; sepalis lateralibus paululo obliquis. Petala sepalo postico agglutinata, apice libera, basi truncata. Labellum sessile, carnosum, margine supra basin utrinque lateris columnae agglutinatum, apice recurvum. Columna erecta, cylindrica, facie puberula, basi in pedem brevem, obliquum producta; stigmata 2, confluentia, biloba; rostellum anguste triangulare, acuminatum. Anthera umbonata, acuta; pollinia clavata, viscidio parvulo, subrotundo. Ovarium cylindricum, sessile, leviter tortum.

Planta muscicola, tubera ellipsoidea, pubescenti; foliis hysteranthis, basilaribus, petiolatis; scapo erecto, gracili, plurivaginato, supra laxe paucifloro; floribus parvulis.

Sepals similar, parallel, connivent, free to base; dorsal sepal concave; lateral sepals somewhat oblique at base, but not didymous. Petals agglutinate with dorsal sepal, free at apex, with truncate, non-decurrent base. Lip sessile, fleshy, concave, lateral margins agglutinate with sides of column, recurved at apex. Column erect, cylindric, with a puberulent front, basally produced in a short oblique foot on top of ovary; stigmata 2, confluent, bilobed; rostellum narrowly triangular, acuminate with sinuous sides. Anther umbonate, acute; pollinia clavate with a small, subrotund viscidium. Ovary cylindric, sessile, slightly twisted.

Plants growing among mosses on tree trunks with a single ellipsoid, pubescent tuber at base. Leaves hysteranthous, basal,

petiolate. Scape erect, slender, several-sheathed, terminated by a loosely few-flowered spike. Flowers small.

TYPE: *Spiranthes muscicola* Garay & Dunsterv.

One species native to the high Andes of Venezuela.

Index to species.

Stalkya muscicola (Garay & Dunsterv.) Garay, comb. nov.
Basionym: Spiranthes muscicola Garay & Dunsterv., Venez. Orch. Ill. 4: 280, 1966.

Stenoptera Presl
actinosophila (Barb.Rodr.) Cogn. = Eurystyles actinosophila (Barb.Rodr.) Schltr.
ananassocomos Rchb.f. = Eurystyles ananassocomos (Rchb.f.) Schltr.
Guentherana Krzl. = Eurystyles Guentherana (Krzl.) Garay
Lorenzii Cogn. = Eurystyles Lorenzii (Cogn.) Schltr.
Roehlii Schnee = Eurystyles Cotyledon Wawra

Stenorrhynchos L.C.Rich. ex Spreng., Syst. Veg. 3: 677, 1826.

Etymology: *Stenos* = narrow and *rhynchos* = snout, in reference to the slender rostellum.

Sepals similar, free, parallel, rather tightly connivent, with flaring apices; dorsal sepal concave, free from column; lateral sepals oblique, slightly gibbose at base, but not decurrent. Petals agglutinate with dorsal sepal, without free apices, at most slightly oblique at base. Lip sessile at conduplicate, to gibbose base with the margins callose-thickened; blade conduplicate, arcuate with recurved apex; lateral margins agglutinate with sides of column. Column short, stout, with a distinct oblique base on top of the ovary; stigmata 2, approximate to confluent; rostellum rigid, linear-lanceolate to almost acicular, sharp-pointed. Anther narrowly ovate-lanceolate, cordate at base, acute above; pollinia linear-clavate with rather long, linear-laceolate viscidium. Ovary obliquely clavate to obovate, sessile, somewhat twisted.

Terrestrial, erect, often robust plants. Roots fleshy, fasciculate, tuberous, commonly stipitate. Leaves commonly synanthous, rarely hysteranthous, usually basal, occasionally cauline

with cuneate bases. Stem erect, prominently vaginate, terminated by a many-flowered spike. Flowers large, showy.

LECTOTYPE: *Neottia speciosa* Jacq. [Britton & Millsp., Bahama Fl. 86, 1920]

Nine species native to the American tropics.

Index to species.

acianthiforme (Rchb.f. & Warm.) Cogn. = Nothostele acianthiformis (Rchb.f. & Warm.) Garay
actinosophilum Barb.Rodr. = Eurystyles actinosophila (Barb.Rodr.) Schltr.
albescens Barb.Rodr. = Pteroglossa macrantha (Rchb.f.) Schltr.
albicans Cogn. = Pelexia albicans (Cogn.) Schltr.
apetalum Krzl. = Sacoila apetala (Krzl.) Garay
aphyllum (Hook.) Lindl. = Sacoila lanceolata (Aubl.) Garay
Arechavaletanii Barb.Rodr. = Skeptrostachys Arechavaletanii (Barb.Rodr.) Garay
argenteum Griseb. Sphalm. = Sacoila argentina (Griseb.) Garay
argentinum Griseb. = Sacoila argentina (Griseb.) Garay
Arrabidae Rchb.f. = Pelexia Arrabidae (Rchb.f.) Garay
aurantiacum (Llave & Lex.) Lindl.
australe Lindl. = Sacoila lanceolata (Aubl.) Garay
balanophorostachyum (Rchb.f. & Warm.) Cogn. = Skeptrostachys balanophorostachya (Rchb.f. & Warm.) Garay
Berroanum Krzl. = Skeptrostachys Berroana (Krzl.) Garay
bicolor (Griseb.) Schltr. = Lyroglossa Grisebachii (Cogn.) Schltr.
bonariense (Lindl.) Braid 1924 = Pelexia bonariensis (Lindl.) Schltr.
bonariense (Lindl.) Cogn. 1895 = Pelexia bonariensis (Lindl.) Schltr.
bracteosum A. & S. = Coccineorchis bracteosa (A. & S.) Garay
Bradei Schltr. = Sacoila Duseniana (Krzl.) Garay
calcaratum (Sw.) L.C.Rich. = Eltroplectris calcarata (Sw.) Garay & Sweet
calophyllum Porsch = Pelexia novofriburgensis (Rchb.f.) Garay
Canterae Barb.Rodr. = Skeptrostachys balanophorostachya (Rchb.f. & Warm.) Garay
Castillonii Haum. = Odontorrhynchus Castillonii (Haum.) Correa
ceracifolium Barb.Rodr. = Lankesterella ceracifolia (Barb.Rodr.) Mansf.
cerinum (Lindl.) Kl. = Pelexia cerina (Lindl.) Garay
cernuum Lindl. = Coccineorchis cernua (Lindl.) Garay
cinnabarinum (Llave & Lex.) Lindl. = Dichromanthus cinnabarinus (Llave & Lex.) Garay
coccineum (Vell.) Hoehne = Sacoila lanceolata (Aubl.) Garay
Cogniauxii Krzl. = Eurystyles Cogniauxii (Krzl.) Schltr.
comosum Cogn. = Pelexia comosa (Cogn.) Schltr.
congestiflorum Cogn. = Skeptrostachys congestiflora (Cogn.) Garay
cuculliger (Rchb.f. & Warm.) Cogn. = Pelexia cuculligera (Rchb.f. & Warm.) Schltr.

densum Haum. = Skeptrostachys disoides (Krzl.) Garay
Duckeanum Barb.Rodr. ex Hoehne, Nomen = Pelexia laxa (Poepp. & Endl.) Lindl.
Dusenianum Krzl. = Sacoila Duseniana (Krzl.) Garay
Ekmanii Krzl. = Pelexia Ekmanii (Krzl.) Schltr.
epiphytum Barb.Rodr. = Lankesterella caespitosa (Lindl.) Hoehne
esmeralda (Linden & Rchb.f.) Cogn. = Mesadenella cuspidata (Lindl.) Garay
euphlebium Oliver ex Rchb.f. = Pteroglossa euphlebia (Rchb.f.) Garay
exaltatum Krzl. = Skeptrostachys Arechavaletanii (Barb.Rodr.) Garay
flavum (Sw.) Spreng. = Corymborkis flava (Sw.) O. Ktze.
foliosum Schltr. = Sacoila foliosa (Schltr.) Garay
Galeottianum Schltr. = Dichromanthus cinnabarinus (Llave & Lex.) Garay
giganteum Cogn. = Skeptrostachys gigantea (Cogn.) Garay
Glaziovii Cogn. = Mesadenus Glaziovii (Cogn.) Schltr.
gnomus Krzl. = Lankesterella gnoma (Krzl.) Hoehne
goninense Pulle = Pelexia goninensis (Pulle) Schltr.
guatemalense Schltr. = Sacoila lanceolata (Aubl.) Garay
Hassleri Cogn. = Sacoila Hassleri (Cogn.) Garay
Hennisianum Sandt = Beadlea Hennisiana (Sandt) Garay
Hilarianum Cogn. = Pteroglossa Hillariana (Cogn.) Garay
holosericeum Krzl. = Pelexia tamanduensis (Krzl.) Schltr.
hypnophilum Barb.Rodr. = Pelexia novofriburgensis (Rchb.f.) Garay
hysteranthum Barb.Rodr. = Pelexia hysterantha (Barb.Rodr.) Schltr.
icmadophilum Barb.Rodr. = *incerta sedis*
jaliscanum (Wats.) Nash = Sacoila lanceolata (Aubl.) Garay
lanceolatum (Aubl.) L.C.Rich. ex Spreng. = Sacoila lanceolata (Aubl.) Garay
lanuginosum (Rich. & Gal.) Schltr. = Stenorrhynchos aurantiacum (Llave & Lex.) Lindl.
lateritium Krzl. = Skeptrostachys Arechavaletanii (Barb.Rodr.) Garay
latipetalum Cogn. = Skeptrostachys latipetala (Cogn.) Garay
latisepalum Cogn. ex Schltr. = Skeptrostachys latipetala (Cogn.) Garay
laxum Poepp. & Endl. = Pelexia laxa (Poepp. & Endl.) Lindl.
Lindmanianum Krzl.= Pelexia Lindmaniana (Krzl.) Schltr.
Loefgrenii Porsch = Pelexia Loefgrenii (Porsch) Schltr.
longicolle Cogn. = Lanktesterella longicollis (Cogn.) Hoehne
longifolium Cogn. = Pelexia longifolia (Cogn.) Hoehne
lupulinum Lindl. = Stenorrhynchos aurantiacum (Llave & Lex.) Lindl.
Lutzii Pabst = Cotylolabium Lutzii (Pabst) Garay
macranthum (Rchb.f.) Cogn. = Pteroglossa macrantha (Rchb.f.) Schltr.
macropodum Barb.Rodr. = Pelexia macropoda (Barb.Rodr.) Schltr.
madrense Rchb.f. = Stenorrhynchos michuacanum (Llave & Lex.) Lindl.
mattogrossense Hoehne = Pelexia cuculligera (Rchb.f. & Warm.) Schltr.
michuacanum (Llave & Lex.) Lindl.
Millei Schltr. = Stenorrhynchos speciosum (Jacq.) L.C.Rich. ex Spreng.
minarum Krzl. = Pelexia minarum (Krzl.) Schltr.
montanum Lindl. = Dichromanthus cinnabarinus (Llave & Lex.) Garay
montevidense Barb.Rodr. = Skeptrostachys montevidensis (Barb.Rodr.) Garay

navarrense Ames = Coccineorchis navarrensis (Ames) Garay
novofriburgense Rchb.f. = Pelexia novofriburgensis (Rchb.f.) Garay
nutans Kunth & Bouché
oestrifer (Rchb.f. & Warm.) Cogn. = Pelexia oestrifera (Rchb.f. & Warm.) Schltr.
orchioides (Sw.) L.C.Rich. = Sacoila lanceolata (Aubl.) Garay
orobanchoides Krzl. = Pelexia orobanchoides (Krzl.) Schltr.
pachystachyum Krzl. = Skeptrostachys disoides (Krzl.) Garay
papulosum (Llave & Lex.) Lindl. = *incerta sedis*
paraguayense (Rchb.f.) Cogn. = Skeptrostachys paraguayensis (Rchb.f.) Garay
paranahybae (Krzl.) Pabst = Skeptrostachys paranahybae (Krzl.) Garay
parvulum Krzl. = Lankesterella parvula (Krzl.) Pabst
parvum Cogn. = Pelexia parva (Cogn.) Schltr.
pauciflorum Rchb.f. = Funckiella hyemalis (Rich. & Gal.) Schltr.
pedicellatum Cogn. = Sacoila pedicellata (Cogn.) Garay
pilosum Cogn. = Lankesterella pilosa (Cogn.) Hoehne
polyanthum Krzl. = Skeptrostachys montevidensis (Barb.Rodr.) Garay
polystachyon (Sw.) Spreng. = Tropidia polystachya (Sw.) Ames
pteryganthum Rchb.f. & Warm. = Pelexia pterygantha (Rchb.f. & Warm.) Schltr.
pubens (Rich. & Gal.) Schltr.
regium Krzl. = Pteroglossa regia (Krzl.) Schltr.
Lorenzii (Cogn.) Schltr. = Eurystyles Lorenzii (Cogn.) Schltr.
paranaënse Schltr. = Eurystyles paranaënsis (Schltr.) Schltr.
riograndense Krzl. = Sacoila riograndensis (Krzl.) Garay
robustum Krzl. = Pelexia robusta (Krzl.) Schltr.
rupestre (Lindl.) Cogn. = Skeptrostachys rupestris (Lindl.) Garay
saltense (Griseb.) Cogn. = Pelexia saltensis (Griseb.) Schltr.
Sancti-Antonii Krzl. = Sacoila lanceolata (Aubl.) Garay
Sancti-Jacobi Krzl. = Skeptrostachys Sancti-Jacobi (Krzl.) Garay
secundiflorum Lillo & Haum. = Sacoila secundiflora (Lillo & Haum.) Garay
Sodiroi Schltr. = Pelexia hirta (Lindl.) Schltr.
speciosum (Jacq.) L.C.Rich. ex Spreng.
squamulosum (H.B.K.) Spreng. = Sacoila squamulosa (H.B.K.) Garay
Standleyi Ames = Coccineorchis Standleyi (Ames) Garay
stenanthum Cogn. = Pelexia stenantha (Cogn.) Schltr.
stenophyllum Cogn. = Skeptrostachys balanophorostachya (Rchb.f. & Warm.) Garay
sulphureum (Llave & Lex.) Lindl. = Stenorrhynchos michuacanum (Llave & Lex.) Lindl.
tamanduënse Krzl. = Pelexia tamanduënsis (Krzl.) Schltr.
taquaremboënse Barb.Rodr. = Beadlea taquaremboënsis (Barb.Rodr.) Garay
Tonduzii (Schltr.) Schltr. = Mesadenella Tonduzii (Schltr.) Pabst & Garay
umbrosum Barb.Rodr. = Sarcoglottis umbrosa (Barb.Rodr.) Schltr.
vaginatum Cogn. 1906 = Pelexia paraguayensis Garay
vaginatum (H.B.K.) Spreng. 1826
ventricosum Cogn. = Pelexia ventricosa (Cogn.) Schltr.

venustum Barb.Rodr. = Beadlea venusta (Barb.Rodr.) Garay
viride Cogn. = Pelexia viridis (Cogn.) Schltr.
vulnerarium Rojas = *incerta sedis*
Weirii (Rchb.f.) Cogn. = Pelexia laxa (Poepp. & Endl.) Lindl.

Stigmatosema Garay, gen. nov.

Etymology: *Stigma* = mark and *sema* = sign, in reference to the large, flared rostellum.

Sepala subsimilia, subparallela, libera; sepalo postico concavo, sepalis lateralibus minore angusteque; sepalis lateralibus obliquis, mentum non formantibus. Petala sepalo postico agglutinata, apice libera, basi truncata. Labellum sessile, tenue, conduplicato-excavatum, basin versus obscure bicallosum, apice recurvum. Columna brevis, cylindrica, facie puberula, basi obliqua; stigmata 2, distincta; rostellum subquadrato-flabellatum, truncatum, in medio sulcatum, tenue. Anthera ovata, concava, obtusa; pollinia clavata, viscidio ovato, satis magno. Ovarium oblique fusiforme, sessile, paululo tortum.

Plantae terrestres, graciles; radicibus fasciculatis, tuberosis, stipitato-fusiformibus; foliis basilaribus, petiolatis; scapo gracili, suberecto, plurivaginato, apice laxe paucifloro; floribus parvulis, spicatis.

Sepals subsimilar, subparallel, free; dorsal sepal concave, smaller and narrower than the lateral sepals; lateral sepals oblique without forming a mentum. Petals agglutinate with dorsal sepal, free at apex and truncate at base. Lip sessile, thin, conduplicate-excavate, obscurely bicallose near base, the apex recurved. Column short, cylindric, with a puberulent front, oblique at base, not truly forming a distinct foot on top of ovary; stigmata 2, distinctly separate; rostellum subquadrate-flabellate, truncate, sulcate in middle, thin, pliable. Anther ovate, concave, obtuse; pollinia clavate with a rather large viscidium. Ovary obliquely fusiform, sessile, somewhat twisted.

Terrestrial, slender plants. Roots fasciculate, tuberous, stipitate-fusiform. Leaves basal, petiolate. Scape slender, suberect, several-sheathed, terminated by a loosely few-flowered spike. Flowers small.

TYPE: *Brachystele Hatschbachii* Pabst.

Two species native to Brazil, Paraguay and Argentina.

Index to species.

Stigmatosema Hatschbachii (Pabst) Garay, comb. nov.
Basionym: Brachystele Hatschbachii Pabst in Bradea 2: 80, 1976.
Stigmatosema polyaden (Vell.) Garay, comb. nov.
Basionym: Serapias polyaden Vell., Fl. Flumin. 9: t.56, 1831.

Synassa Lindl.
corymbosa Lindl. = Sauroglossum corymbosum (Lindl.) Garay
dilatata Lindl. ex Krzl. = Sauroglossum corymbosum (Lindl.) Garay

Synoplectris Raf.
picta (R. Br.) Raf. = Sarcoglottis acaulis (J.E.Sm.) Schltr.
viridis Raf. = Sarcoglottis grandiflora (Lindl.) Kl.

Thelyschista Garay, gen. nov.

Etymology: *Thelys* = female and *schistos* = split, divided, in reference to the nature of the cleft stigmata.

Sepala plus minusve similia, leviter divergentia, ringentia, usque ad basin libera; sepalo postico concavo; sepalis lateralibus obliquis, basi leviter dilatatis, mentum obscurum cum pede columnae formantibus. Petala margine interiore sepalo postico valde agglutinata, basi paululo obliqua. Labellum e cuneato-canaliculata basi conduplicatum, sessile, margine basin incrassatum, in medio columnae lateraliter agglutinatum. Columna satis crassa, basi in pedem brevem, obliquum producta; stigmata 2, patelliformia, bipartita, valde separata; rostellum anguste-triangulare, acuminatum, satis tenue. Anthera anguste-elliptica, obtusa; pollinia lineari-clavata, separata, viscidio oblanceolato-obovato, valde conspicuo affixa. Ovarium sessile, oblique fusiforme, leviter tortum.

Herbae terrestres, elatae; radicibus fasciculatis; foliis basilaribus, rosulatis, basi cuneato-subpetiolatis; scapo erecto, vaginato, apice subdense spicato, sursum plus minusve cernuo; floribus satis magnis, suberectis.

Sepals more or less similar, somewhat divergent, ringent, completely free to base; dorsal sepal concave; lateral sepals oblique at the dilated base, with column-foot forming an obs-

cure mentum. Petals agglutinate with dorsal sepals, with an oblique base. Lip sessile, from a cuneate-canaliculate base conduplicate. The margins at base inerassate, in middle agglutinate with sides of column. Column rather fleshy, heavy, basally produced in a short, oblique foot; stigmata 2, situated on a deeply cleft, biparted, well-separated, more or less cartilaginous plate; rostellum narrowly triangular, acuminate, pliable. Anther narrowly elliptic, obtuse; pollinia linear-clavate, separate, with a large, conspicuous, oblanceolate-obovate viscidium. Ovary sessile, obliquely fusiform, somewhat twisted.

Terrestrial, tall plants. Roots fasciculate, fleshy. Leaves basal, rosulate, with cuneate-subpetiolate bases. Scape erect, vaginate, terminated by a subdensely many-flowered spike which is more or less cernuous at apex. Flowers rather large, suberect.

TYPE: *Odontorrhynchus Ghillanyi* Pabst

One species, so far known only from Brazil.

Index to species

Thelyschista Ghillanyi (Pabst) Garay, comb. nov.
Basionym: Odontorrhynchus Ghillanyi Pabst in Bradea 2: 166, 1977.

Trachelosiphon Schltr.
actinosophila (Barb.Rodr.) Schltr. = Eurystyles actinosophila (Barb.Rodr.) Schltr.
ananassocomos (Rchb.f.) Schltr. = Eurystyles ananassocomos (Rchb.f.) Schltr.
Cogniauxii (Krzl.) Schltr. = Eurystyles Cogniauxii (Krzl.) Schltr.
colombianum Schltr. = Eurystyles colombiana (Schltr.) Schltr.
cristatum Schltr. = Eurystyles cristata (Schltr.) Schltr.
Lorenzii (Cogn.) Schltr. = Eurystyles Lorenzii (Cogn.) Schltr.
paranaënse Schltr. = Eurystyles paranaënsis (Schltr.) Schltr.

Triorchis Petiver ex Nieuwl.
Beckii (Lindl.) House = Spiranthes lacera (Raf.) Raf.
cernua (L.) Nieuwl. = Spiranthes cernua (L.) L.C.Rich.
gracilis (Bigel.) Nieuwl. = Spiranthes lacera (Raf.) Raf.
Grayi (Ames) Nieuwl. = Spiranthes tuberosa Raf.
laciniata (Small) House = Spiranthes laciniata (Small) Ames
linearis (Rydb.) Nieuwl. = Spiranthes vernalis Engelm. & Gray
longilabris (Lindl.) House = Spiranthes longilabris Lindl.
ochroleuca (Rydb.) Nieuwl.= Spiranthes ochroleuca (Rydb.) Rydb.
odorata (Nutt.) Nieuwl. = Spiranthes odorata (Nutt.) Lindl.

ovalis (Lindl.) House = Spiranthes ovalis Lindl.
ovalis (Lindl.) Nieuwl. = Spiranthes ovalis Lindl.
plantaginea (Raf.) Nieuwl. = Spiranthes lucida (H.H.Eaton) Ames
praecox (Walt.) Nieuwl. = Spiranthes praecox (Walt.) Wats.
Romanzoffiana (Cham.) Nieuwl. = Spiranthes Romanzoffiana Cham.
spiralis (Sw.) House = Spiranthes torta (Thunb.) Garay & Sweet
stricta (Rydb.) Lunell = Spiranthes Romanzoffiana Cham.
stricta (Rydb.) Nieuwl. = Spiranthes Romanzoffiana Cham.
triloba (Small) House = Spiranthes odorata (Nutt.) Lindl.
vernalis (Engelm. & Gray) House = Spiranthes vernalis Engelm. & Gray
xyridifolia (Small) House = Spiranthes vernalis Engelm. & Gray

Tussacia Raf. ex Desv., not Tussaca Raf.
aestivalis (Poir.) Desv. = Spiranthes aestivalis (Poir.) L.C.Rich.
autumnalis (Balb.) Desv. = Spiranthes spiralis (L.) Chevall.

PLATE 10

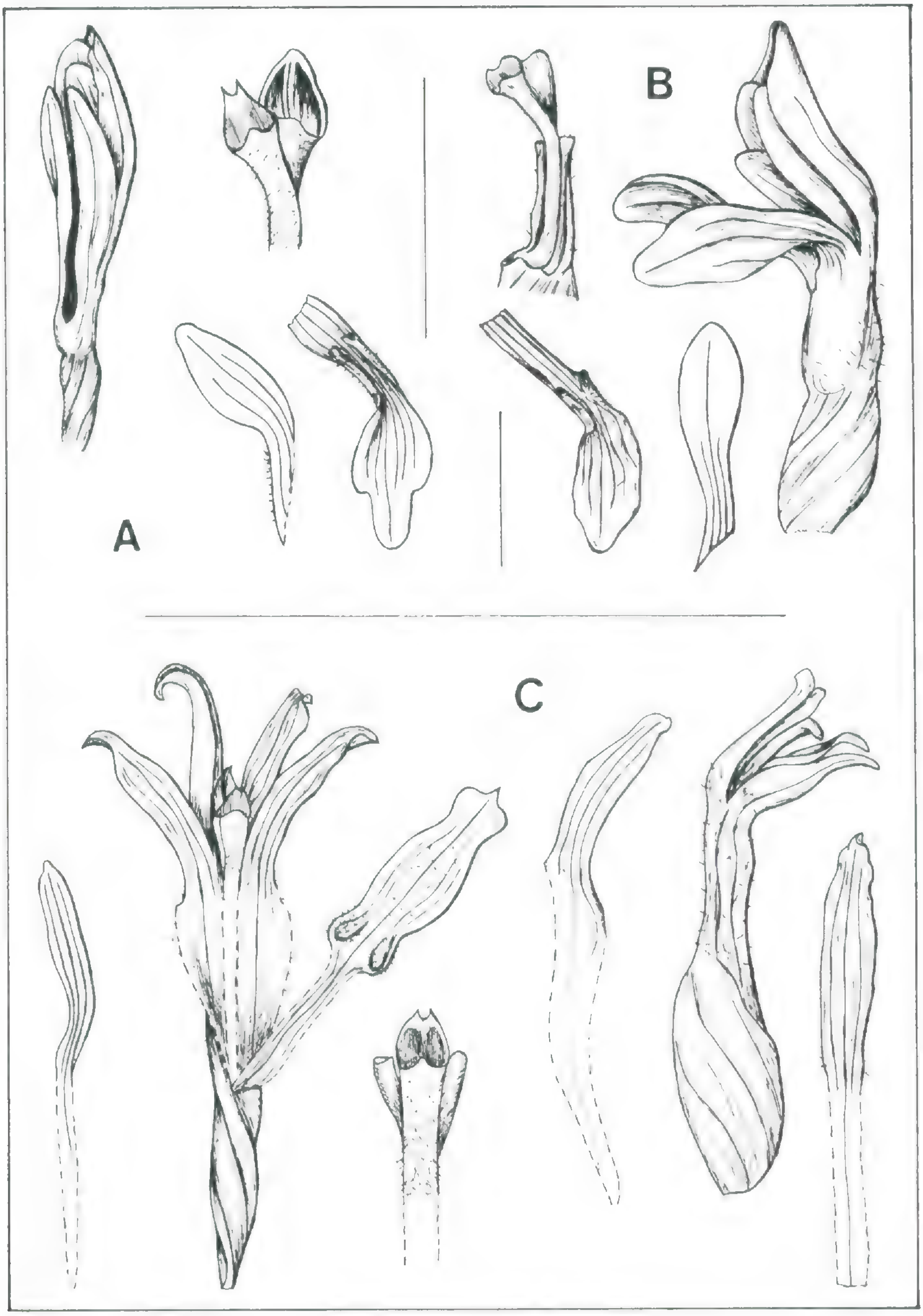

Plate 10.

A. **Aulosepalum hemichrea** (Lindl.) Garay. Type.
B. **Aulosepalum ramentaceum** (Lindl.) Garay. Type.
C. **Aulosepalum tenuiflorum** (Greenm.) Garay. Type.

PLATE 11

Plate 11.
Beadlea cranichoides (Griseb.) Small.

PLATE 12

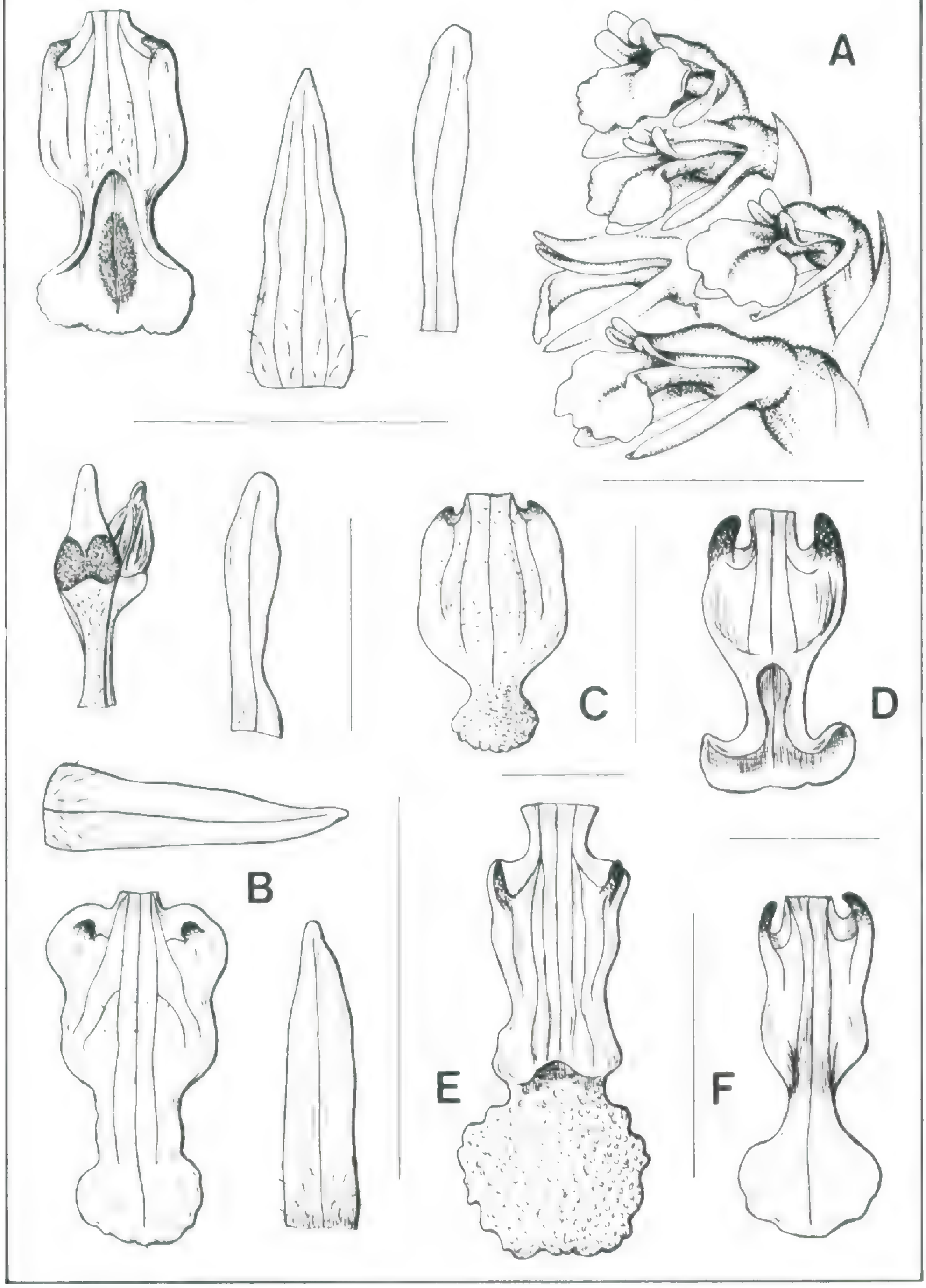

Plate 12.

A. **Beadlea peruviana** (Presl) Garay. Type.
B. **Beadlea elata** (Sw.) Small. (Type of Neottia minor Jacq.)
C. **Beadlea aprica** (Lindl.) Garay. Type.
D. **Beadlea saccata** (Rich. & Gal.) Garay.
E. **Beadlea organensis** Pabst. Type.
F. **Beadlea Prasophyllum** (Rchb.f.) Hamer & Garay. Type.

PLATE 13

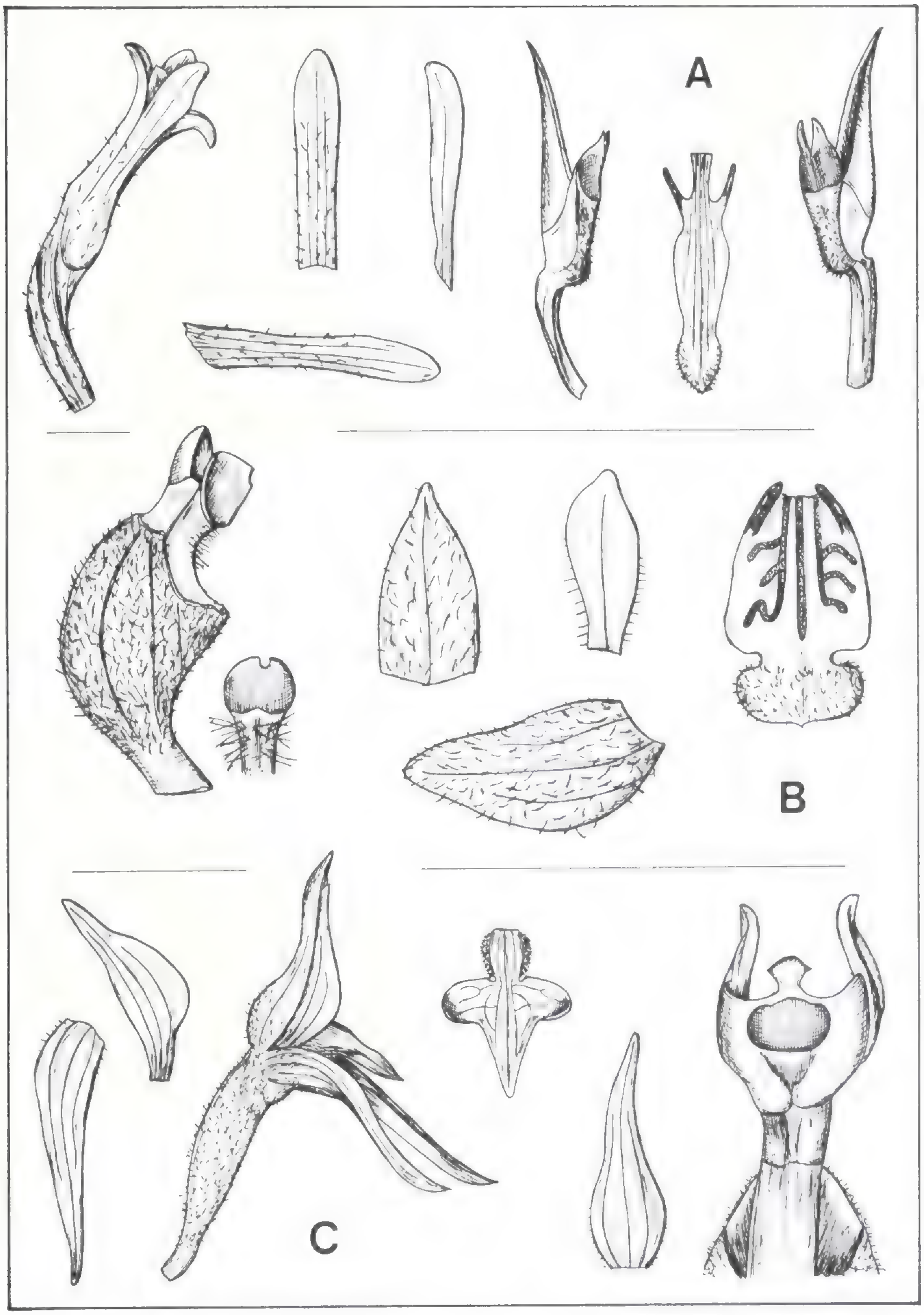

Plate 13.

A. **Beloglottis costaricensis** (Rchb.f) Schltr.
B. **Brachystele bracteosa** (Lindl.) Schltr. Type.
C. **Buchtienia boliviensis** Schltr. Type.

PLATE 14

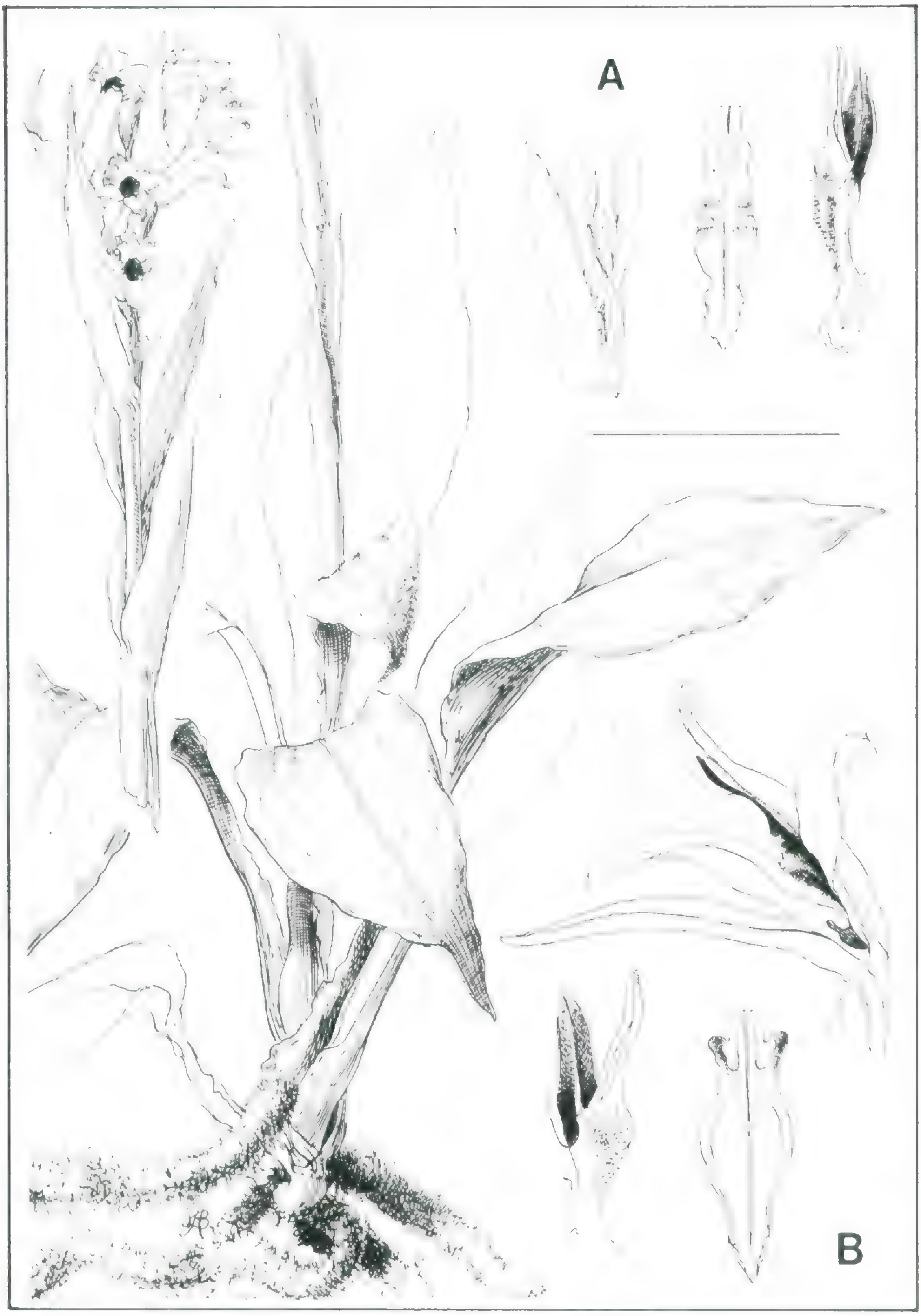

Plate. 14.

A. **Coccineorchis navarrensis** (Ames) Garay. Type.
B. **Coccineorchis Standleyi** (Ames) Garay. Type.

PLATE 15

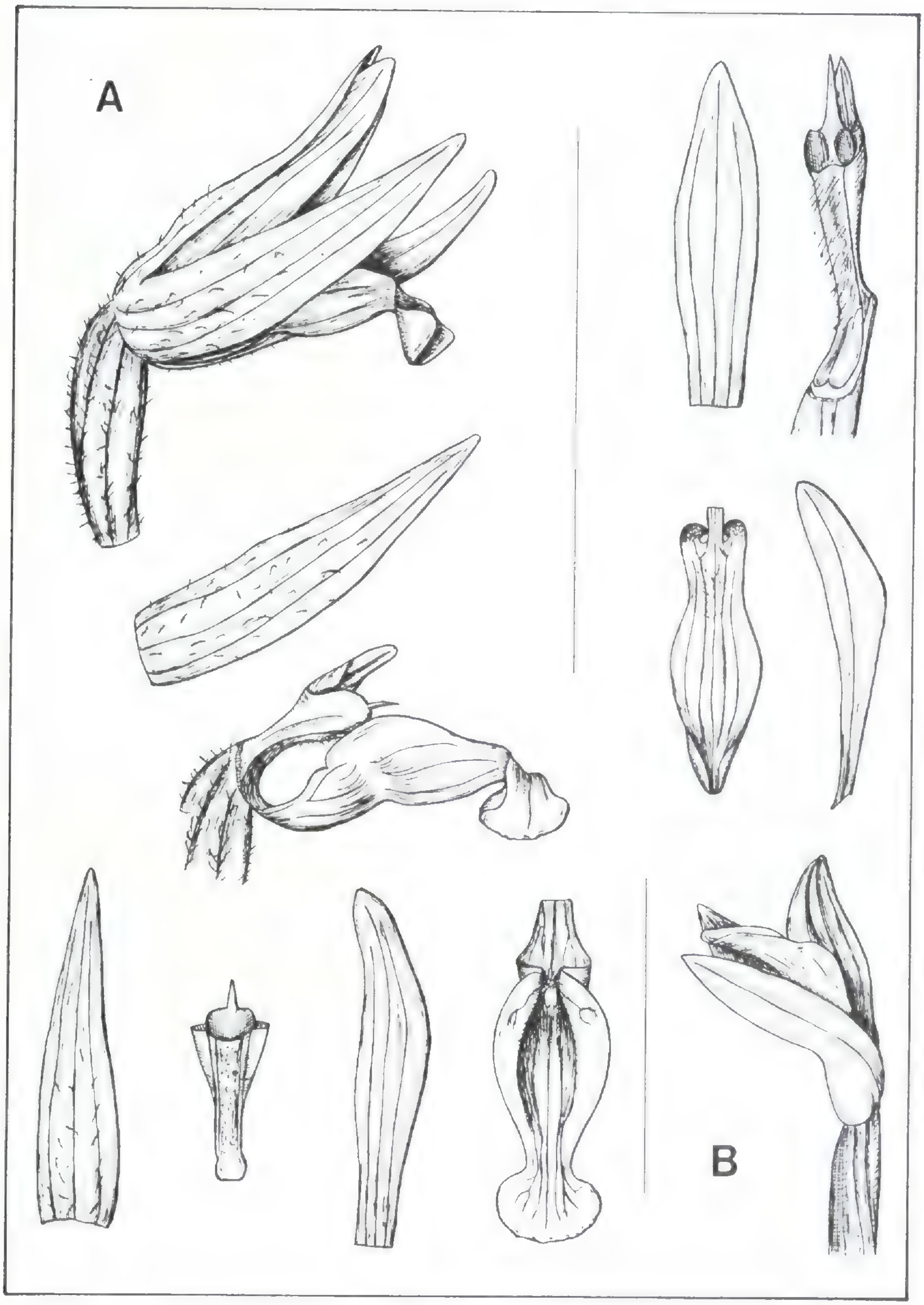

Plate 15.
A. **Cotylolabium Lutzii** (Pabst) Garay. Type.
B. **Coccineorchis cernua** (Lindl.) Garay. Type.

PLATE 16

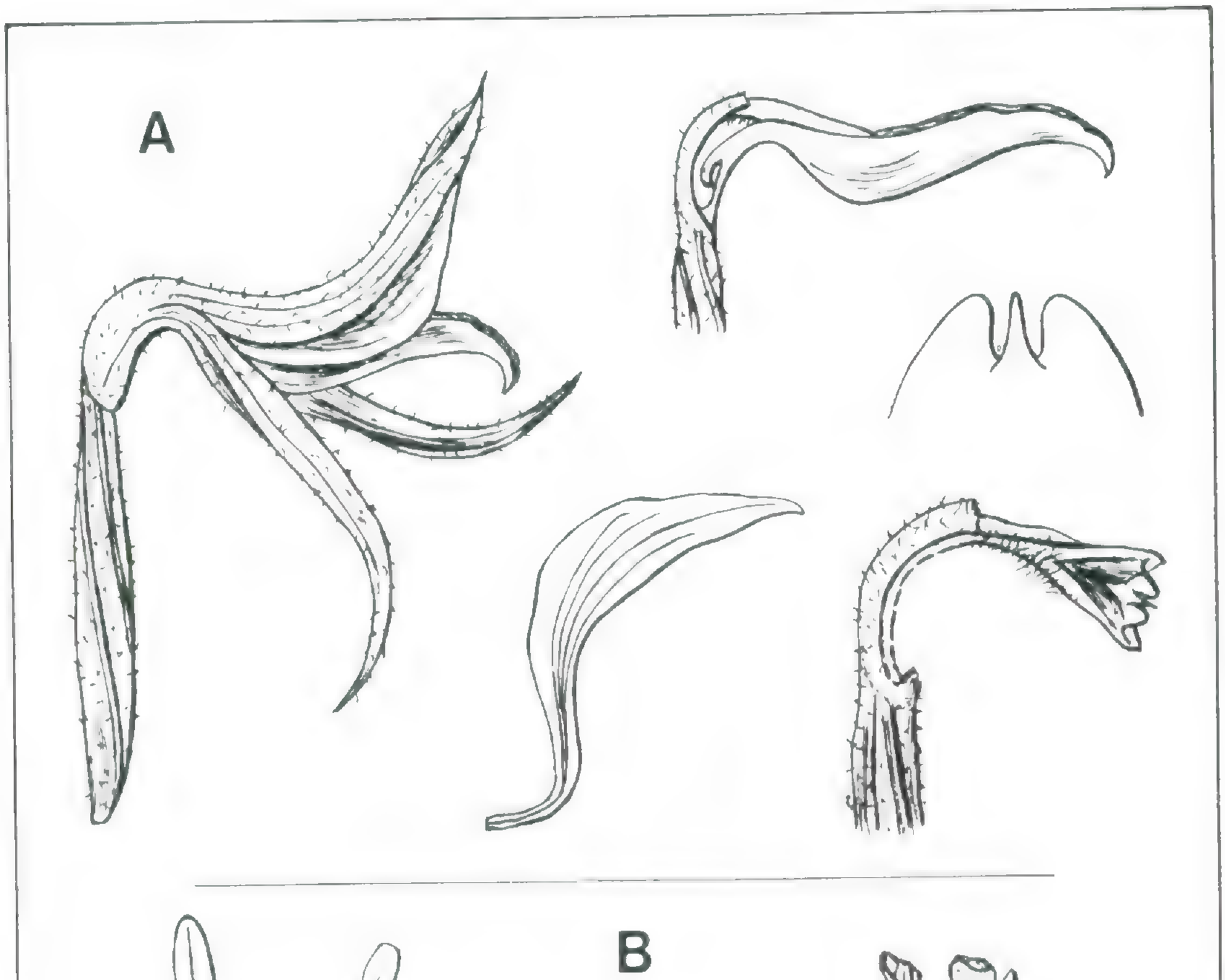

Plate 16.
A. **Cybebus grandis** Garay. Type.
B. **Cyclopogon ovalifolium** Presl. Type.

PLATE 17

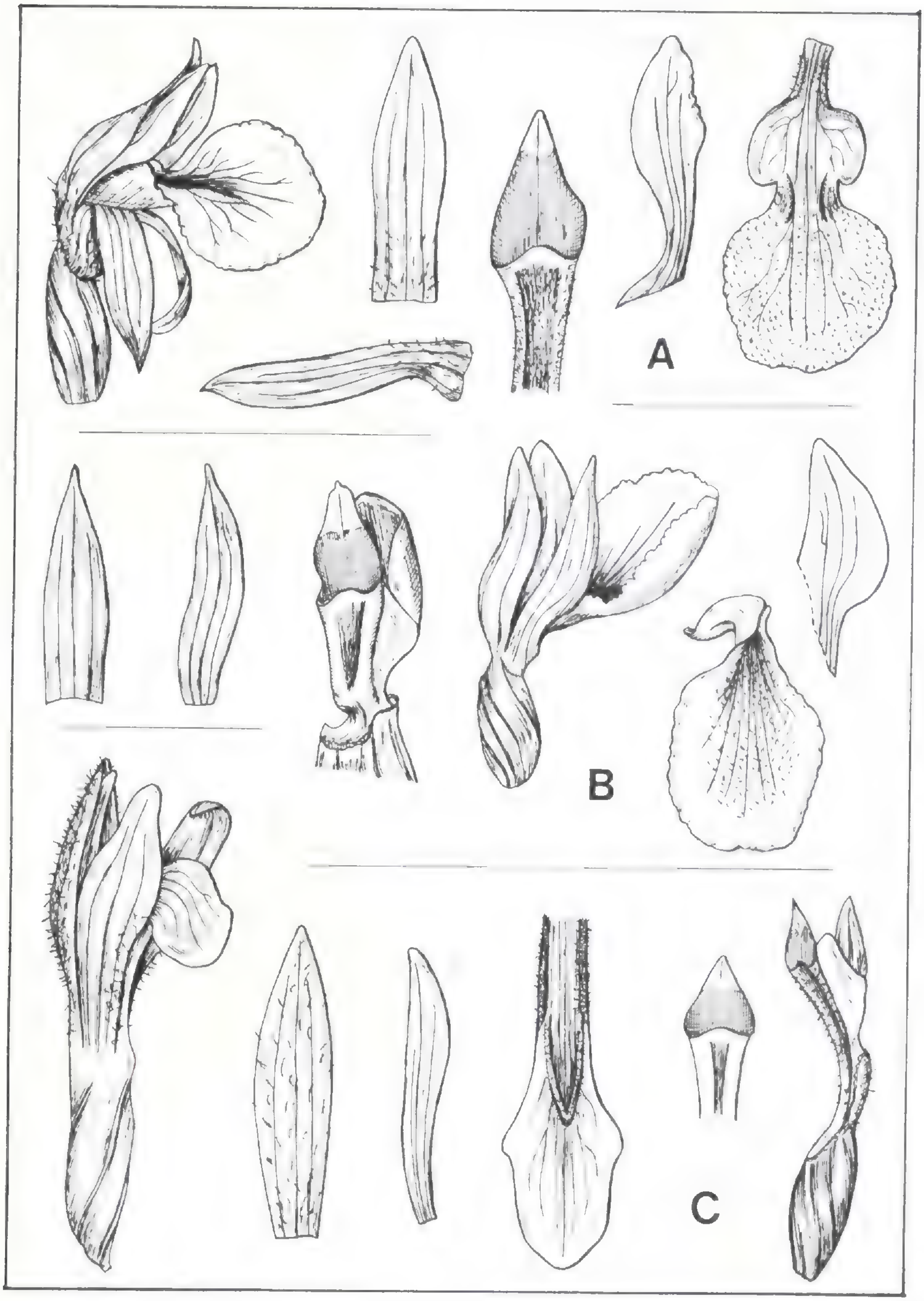

Plate 17.

A. **Deiregyne chartacea** (L.O.Wms.) Garay. Type.
B. **Deiregyne velata** (Robins. & Fern.) Garay. Type.
C. **Deiregyne diaphana** (Lindl.) Garay. Type.

PLATE 18

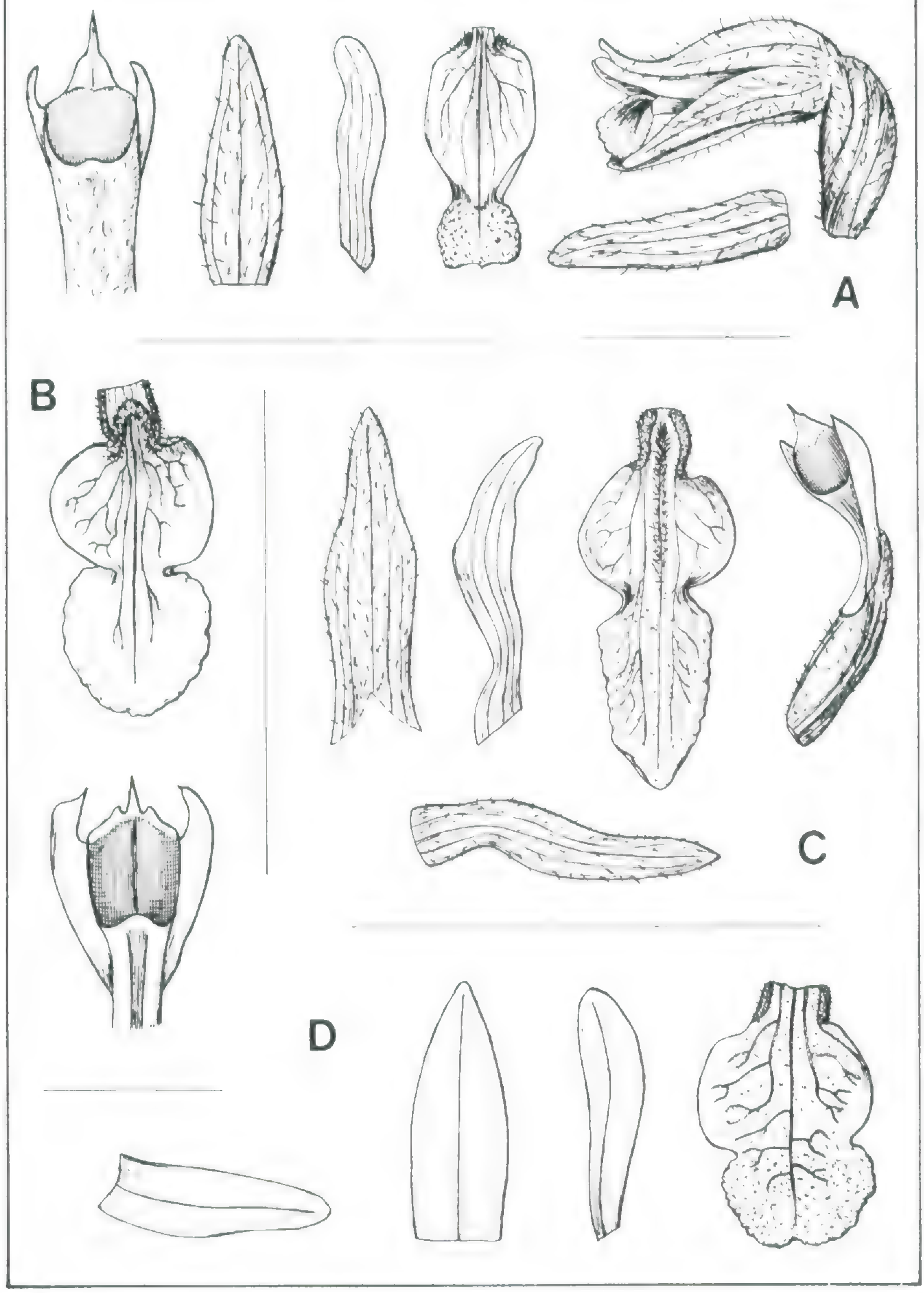

Plate 18.

A. **Deiregyne albovaginata** (C. Schweinf.) Garay. Type.
B. **Deiregyne durangensis** (A. & S.) Garay. (Type of Spiranthes saltensis Ames)
C. **Deiregyne confusa** Garay. Type.
D. **Deiregyne dendroneura** (Sheviak & Bye) Garay. Type.

PLATE 19

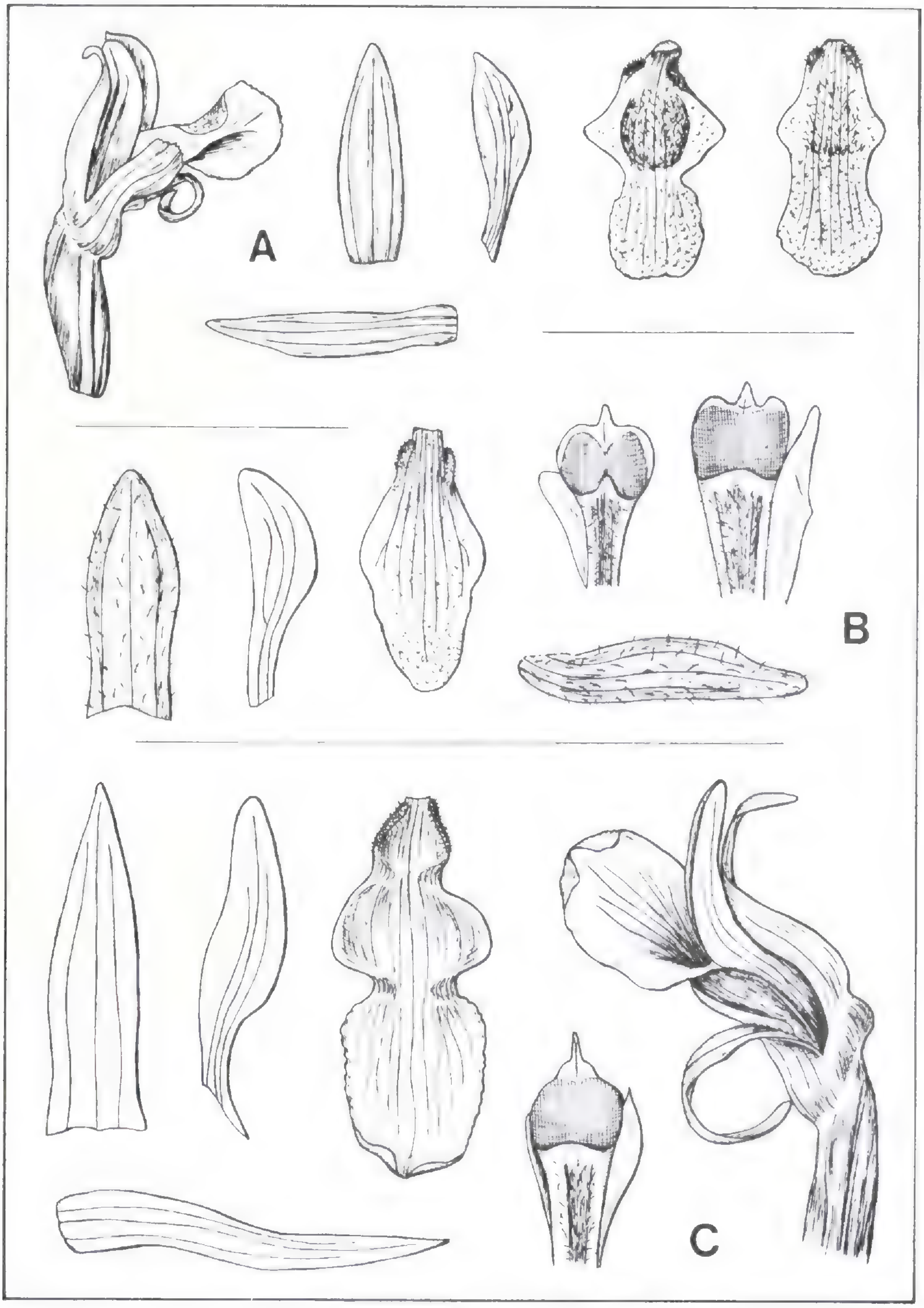

Plate 19.

A. **Deiregyne falcata** (L.O.Wms.) Garay. Type.
B. **Deiregyne rhombilabia** Garay. Type.
B. **Deiregyne obtecta** (C. Schweinf.) Garay. Type.

PLATE 20

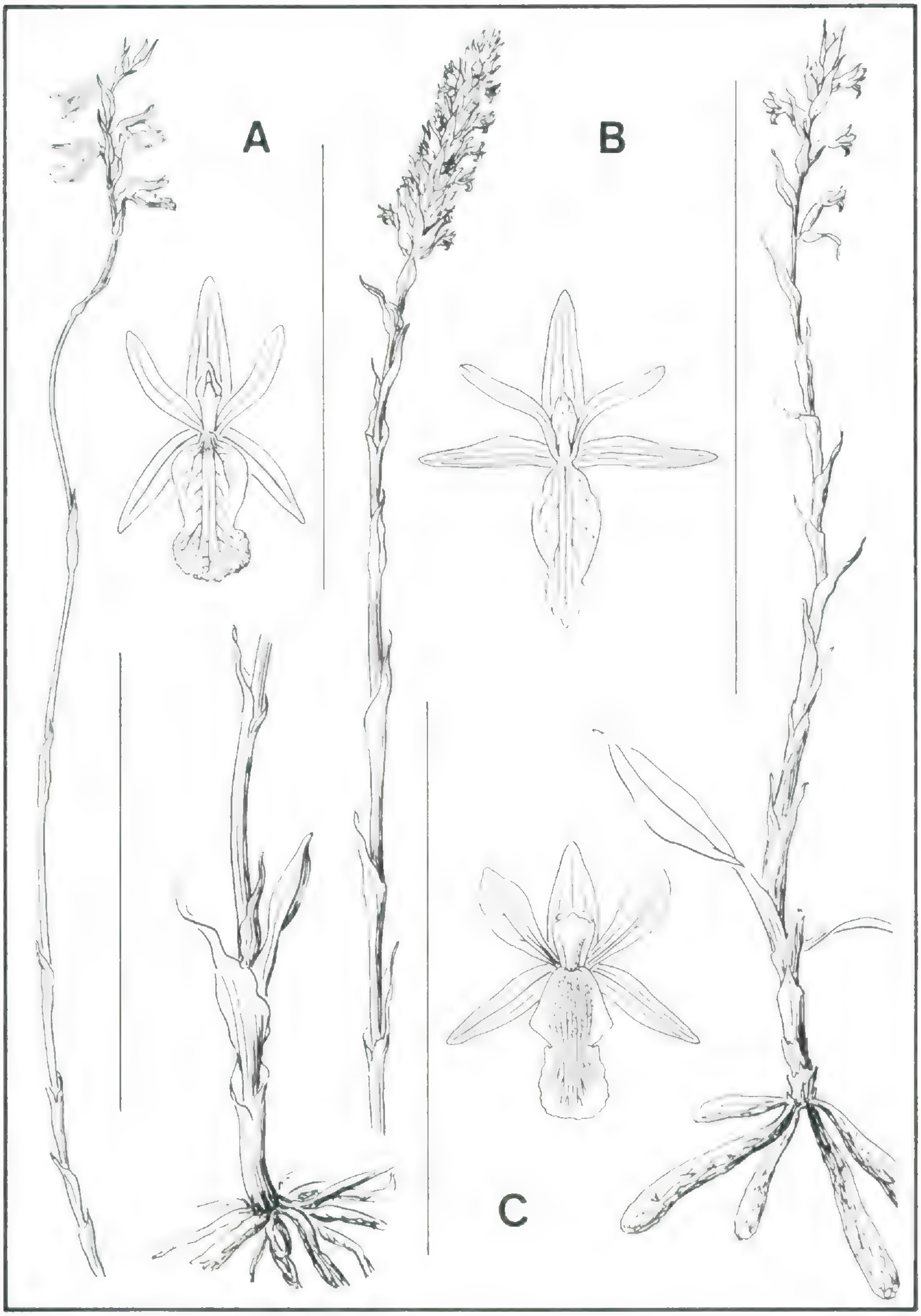

Plate 20.

A. **Deiregyne tenella** (L.O.Wms.) Garay. Type.
B. **Deiregyne pseudopyramidalis** (L.O.Wms.) Garay. Type.
C. **Deiregyne falcata** (L.O.Wms.) Garay. Type.

PLATE 21

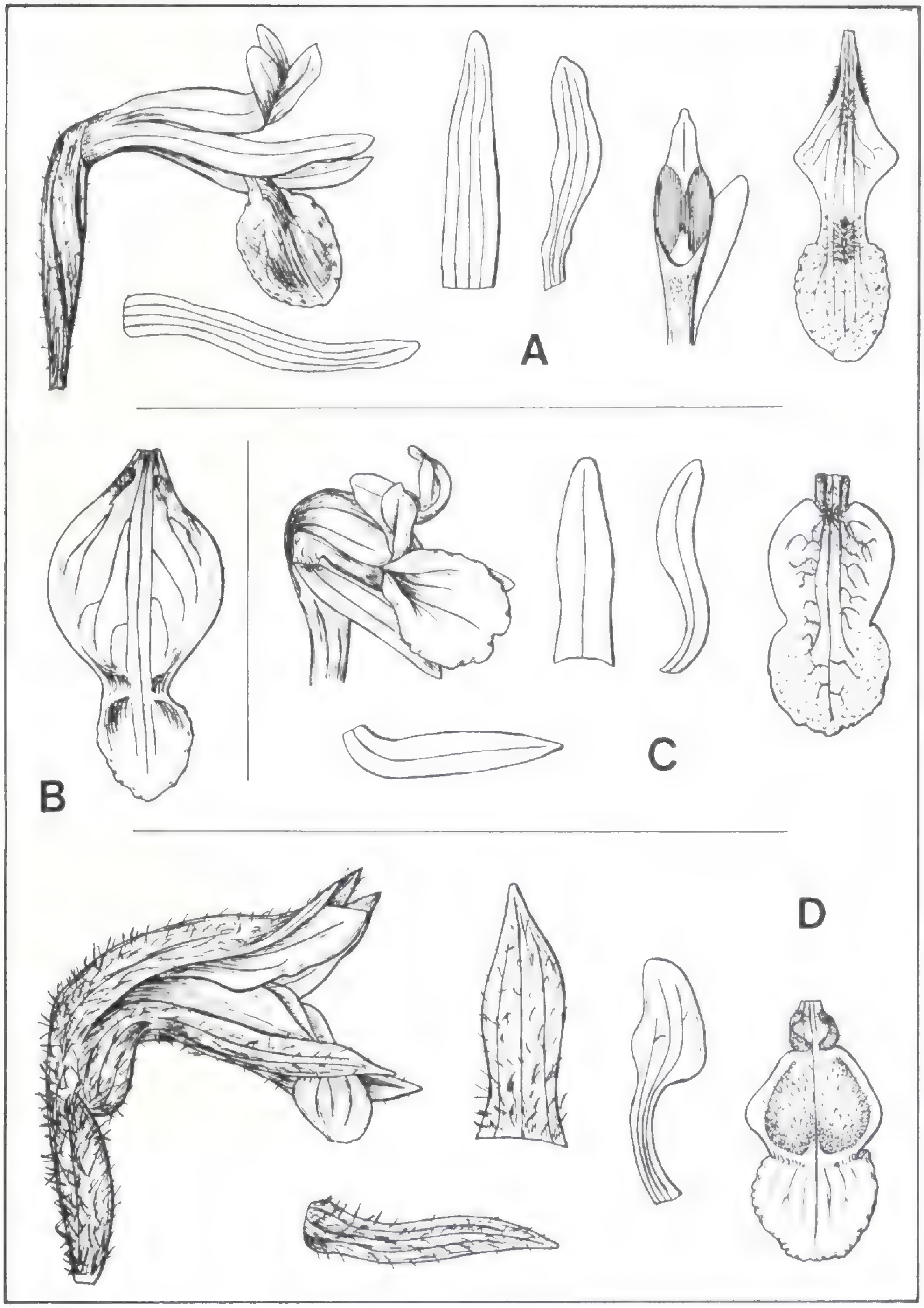

Plate 21.

A. **Deiregyne pandurata** Garay. Type.
B. **Deiregyne pseudopyramidalis** (L.O.Wms.) Garay. Type.
C. **Deiregyne tenella** (L.O.Wms.) Garay. Type.
D. **Deiregyne eriophora** (Robins. & Greenm.) Garay. Type.

PLATE 22

Plate 22.

Dichromanthus cinnabarinus (Llave & Lex.) Garay.

PLATE 23

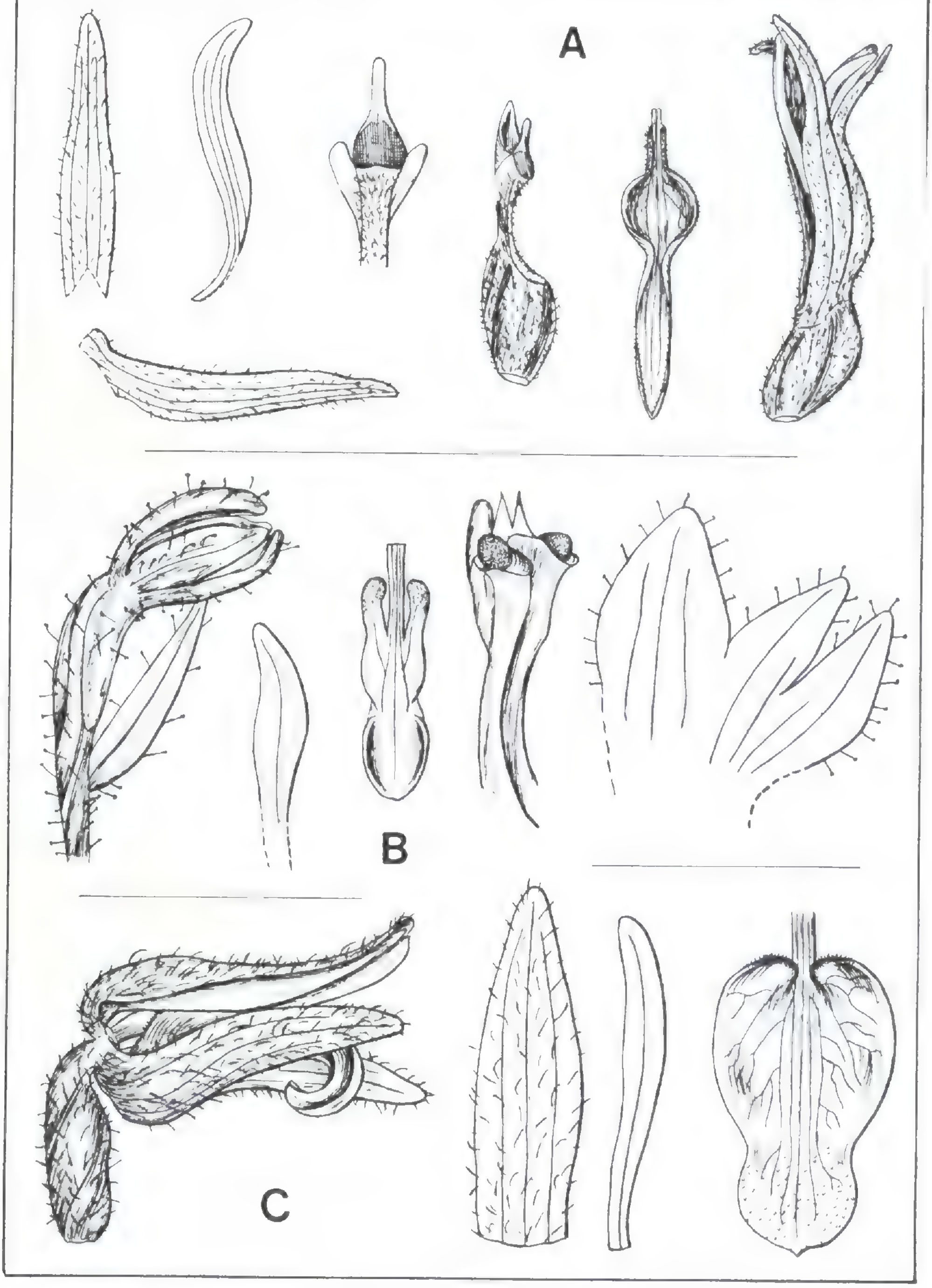

Plate 23.

A. **Dichromanthus cinnabarinus** (Llave & Lex.) Garay.
B. **Discyphus scopulariae** (Rchb.f.) Schltr.
C. **Dithyridanthus densiflorus** (C. Schweinf.) Garay. Type.

PLATE 24

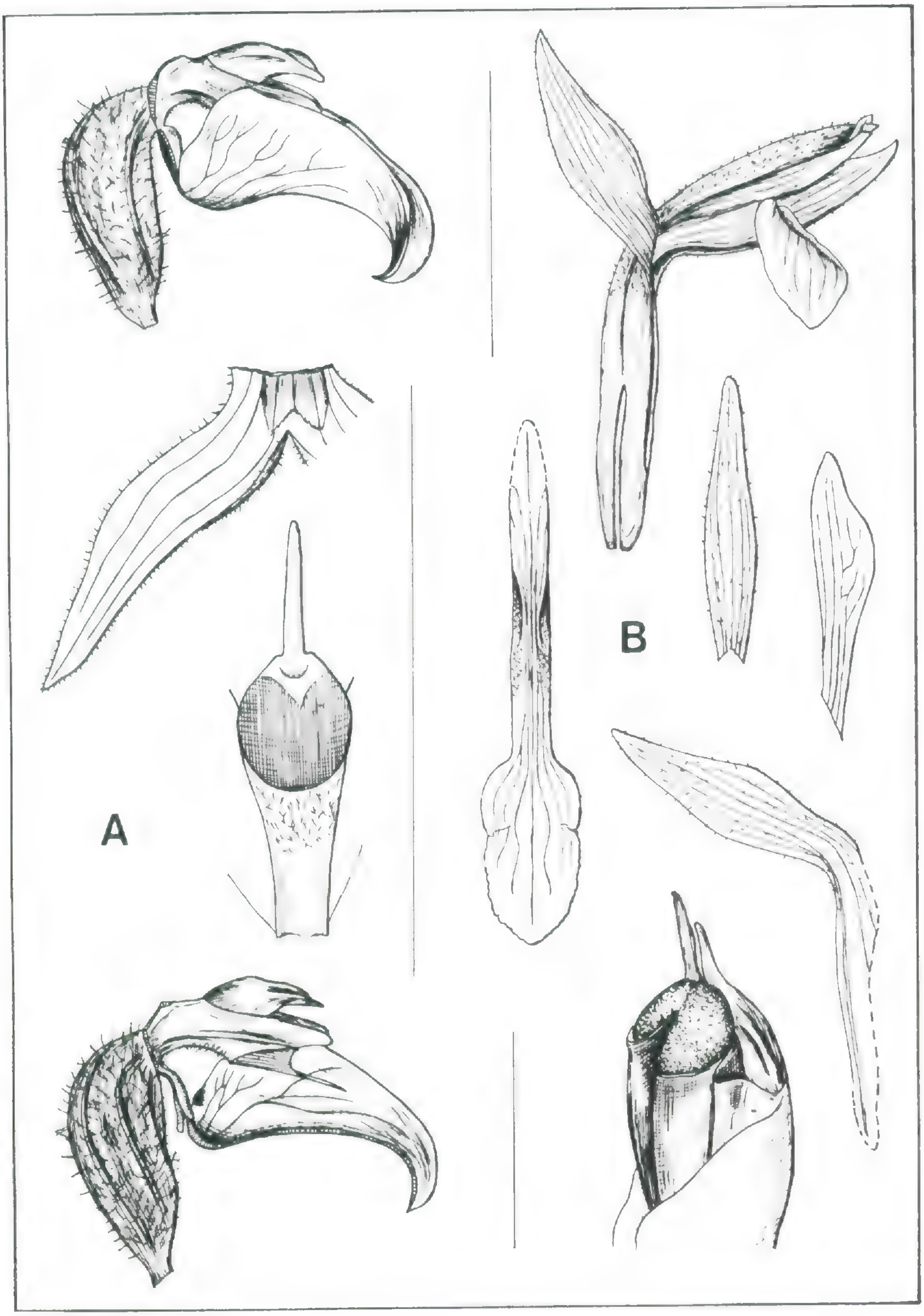

Plate 24.

A. **Dithyridanthus densiflorus** (C. Schweinf.) Garay. Type.
B. **Eltroplectris roseoalba** (Rchb.f.) Hamer & Garay.

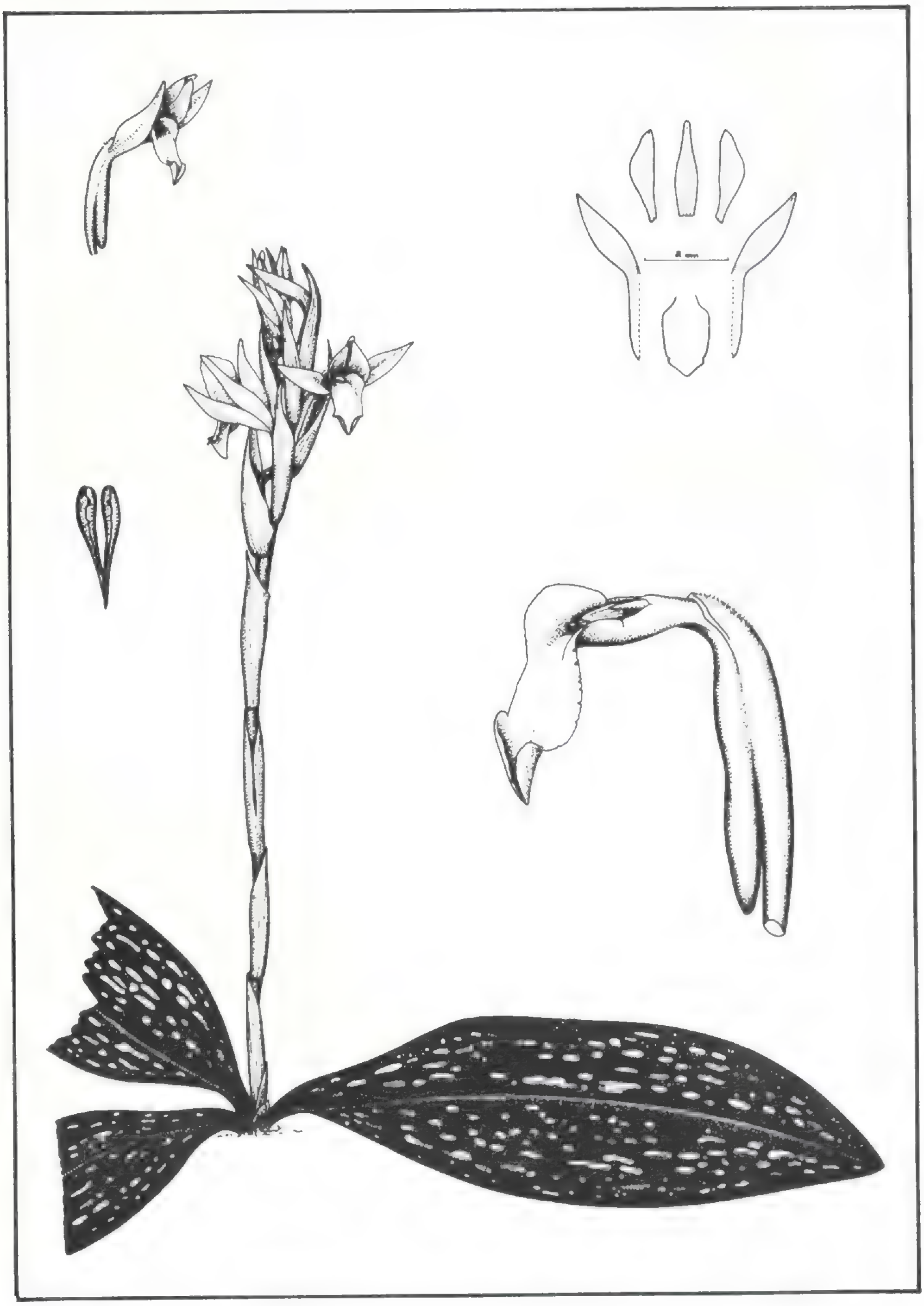

Plate 25.
Eltroplectris roseoalba (Rchb.f.) Hamer & Garay.

PLATE 26

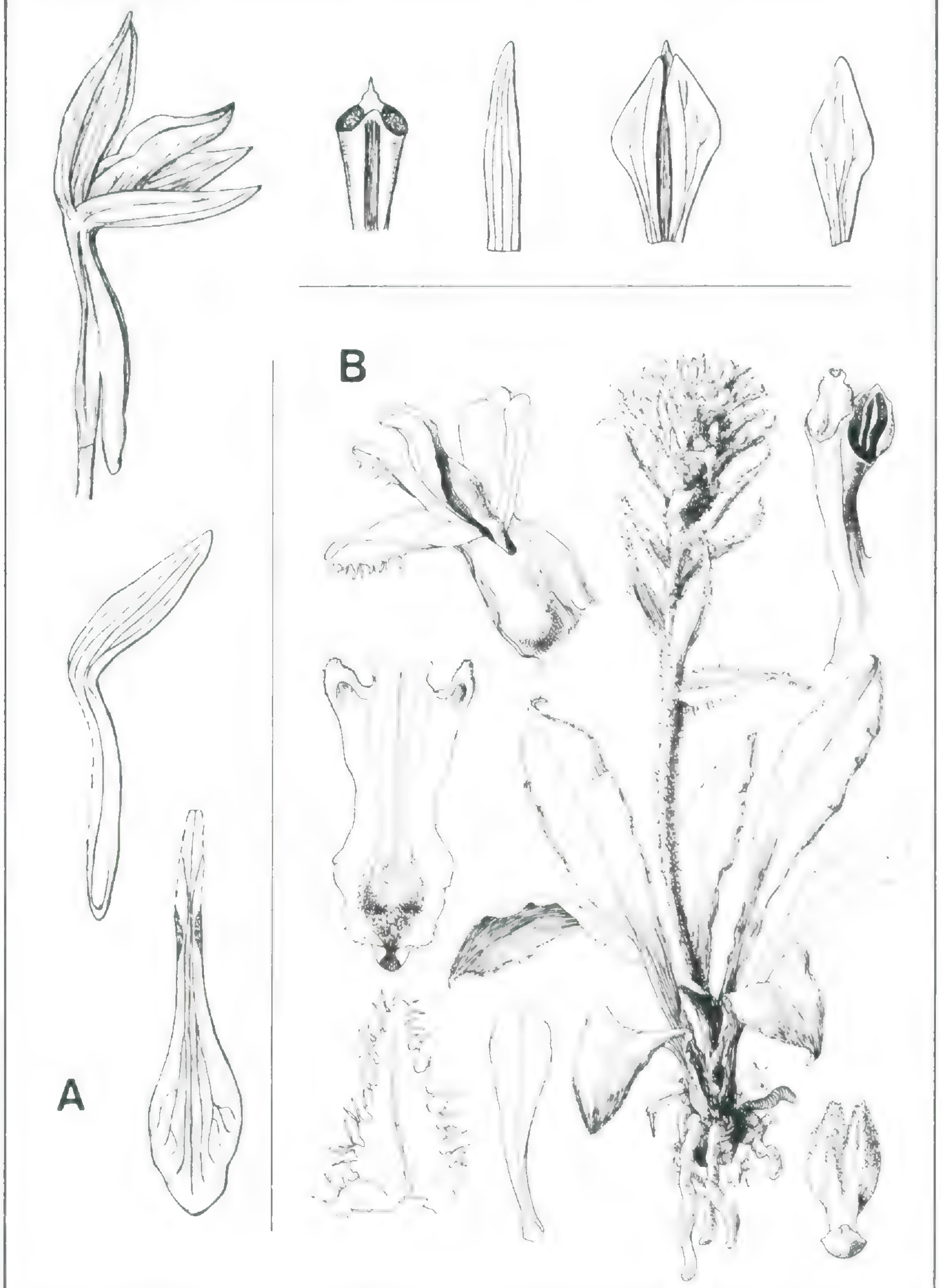

Plate 26.

A. **Eltroplectris Travassosii** (Rolfe) Garay.
B. **Eurystyles Standleyi** Ames. Type.

PLATE 27

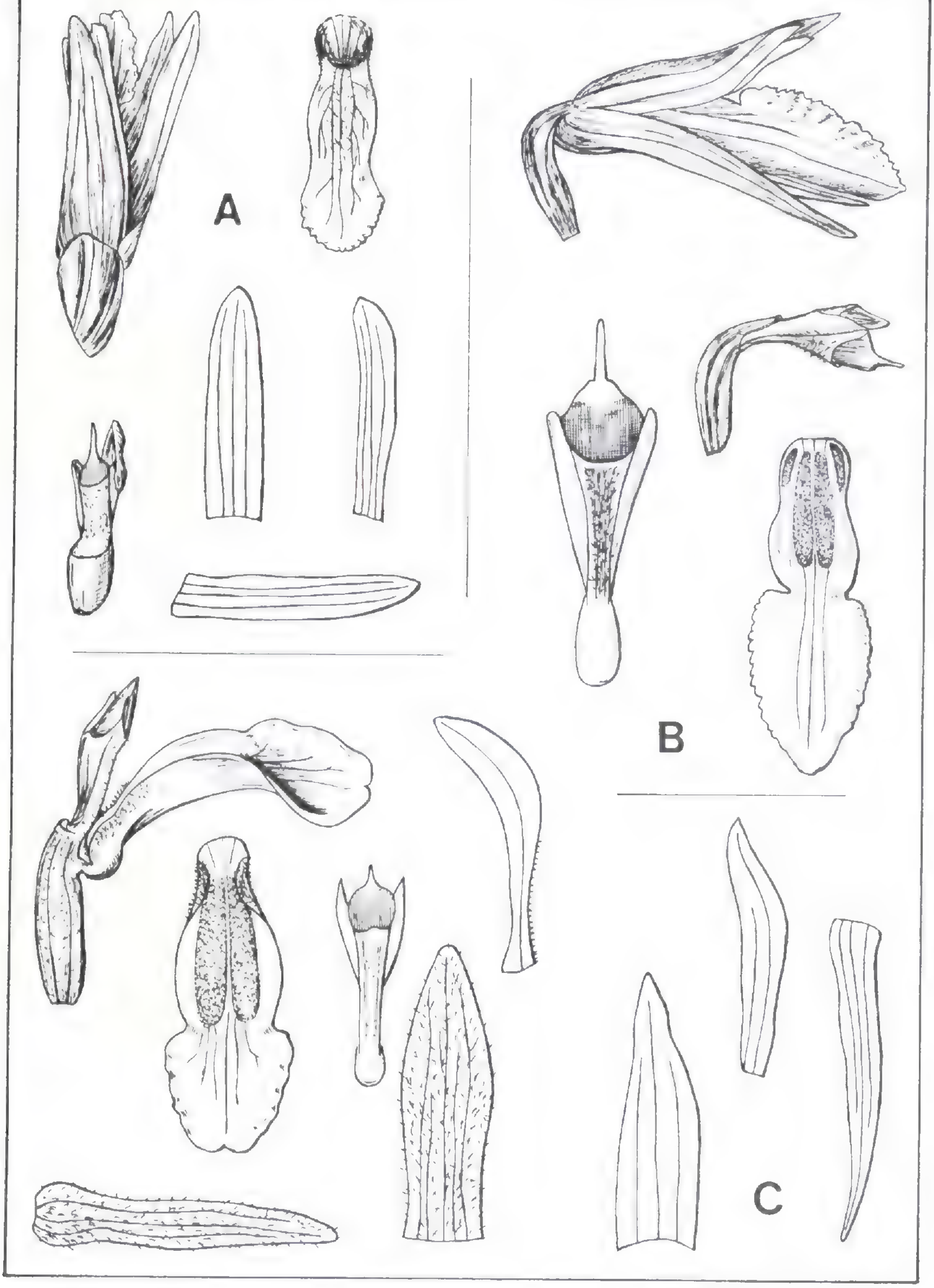

Plate 27.

A. **Funckiella congestiflora** (L.O.Wms.) Garay. Type.
B. **Funckiella hyemalis** (Rich. & Gal.) Schltr. Type.
C. **Funckiella stolonifera** (Ames & Correll) Garay. Type.

PLATE 28

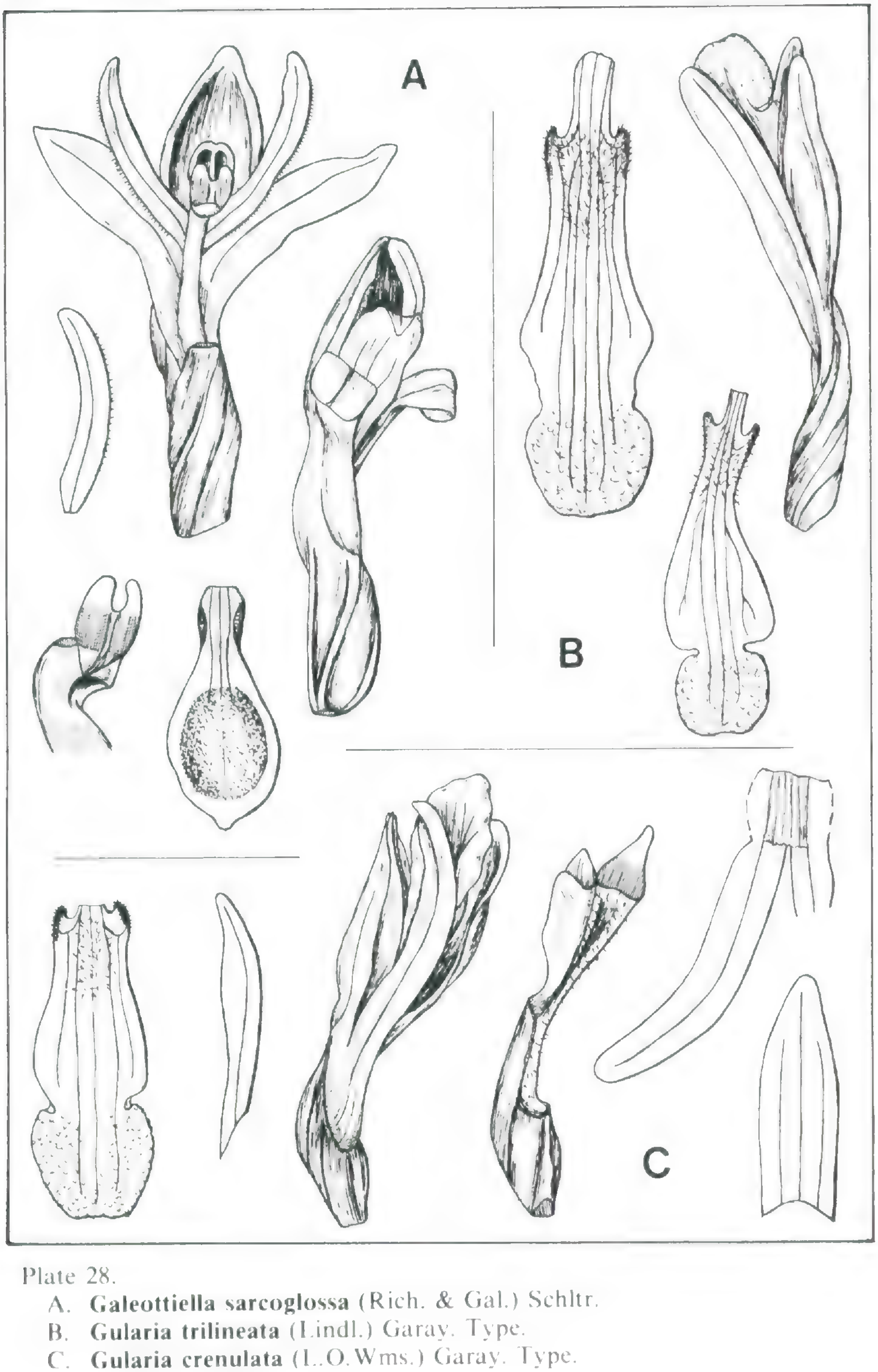

Plate 28.

A. **Galeottiella sarcoglossa** (Rich. & Gal.) Schltr.
B. **Gularia trilineata** (Lindl.) Garay. Type.
C. **Gularia crenulata** (L.O.Wms.) Garay. Type.

PLATE 29

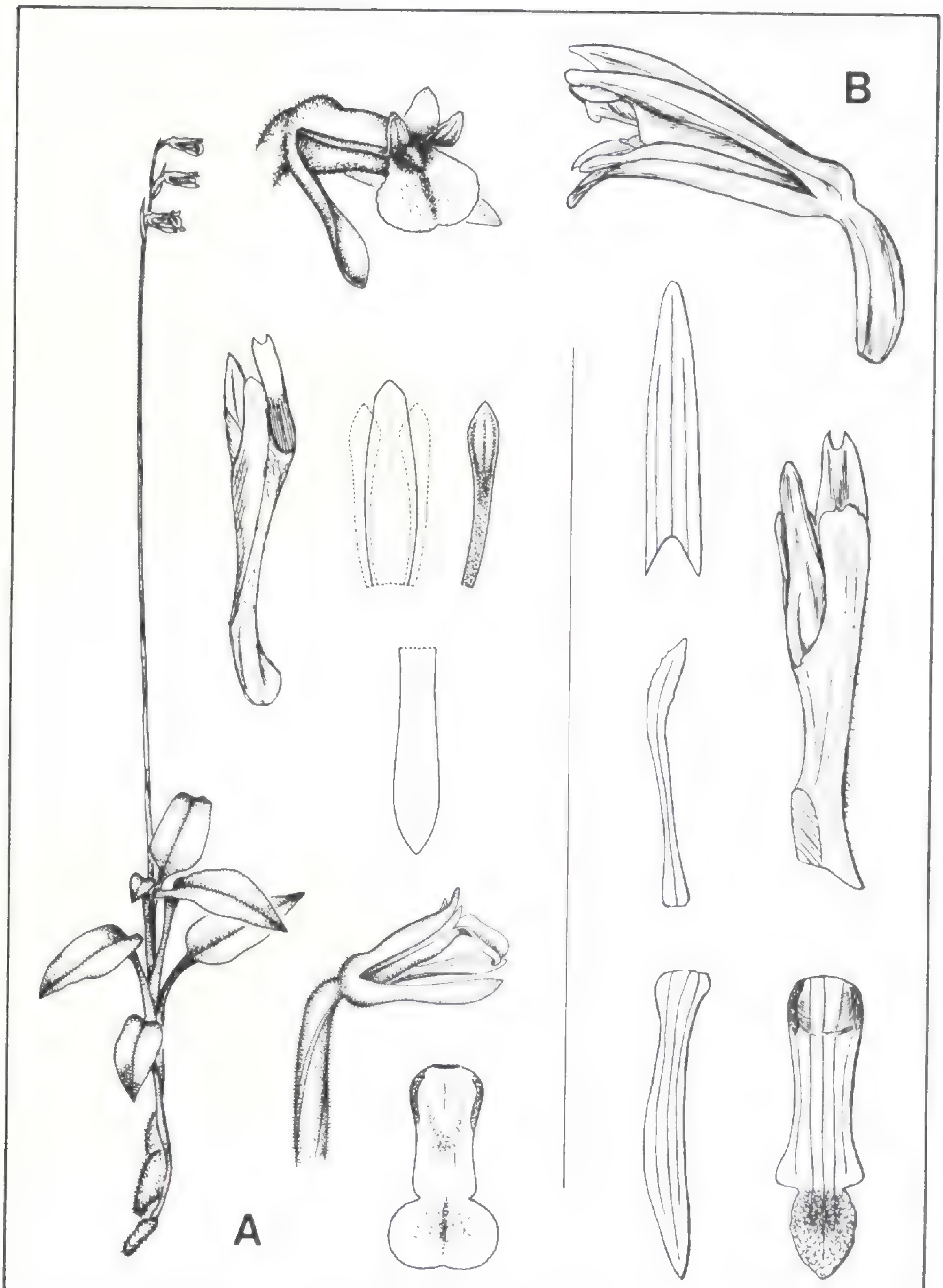

Plate 29.

A. **Hapalorchis cheirostyloides** Schltr.
B. **Hapalorchis trilobata** Schltr.

PLATE 30

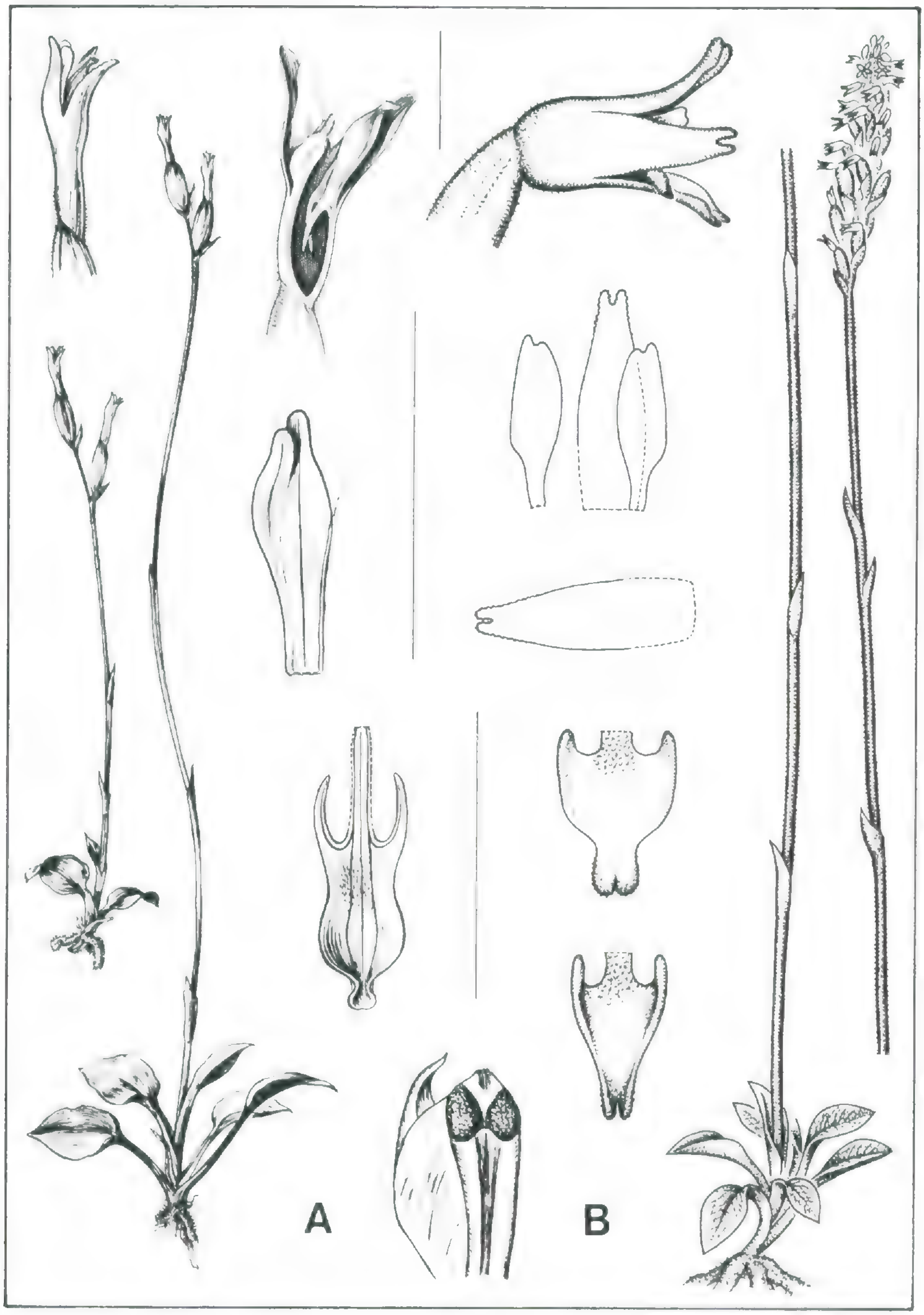

Plate 30.

A. **Helonoma americana** (C. Schweinf. & Garay) Garay. Type.
B. **Helonoma bifida** (Ridl.) Garay.

PLATE 31

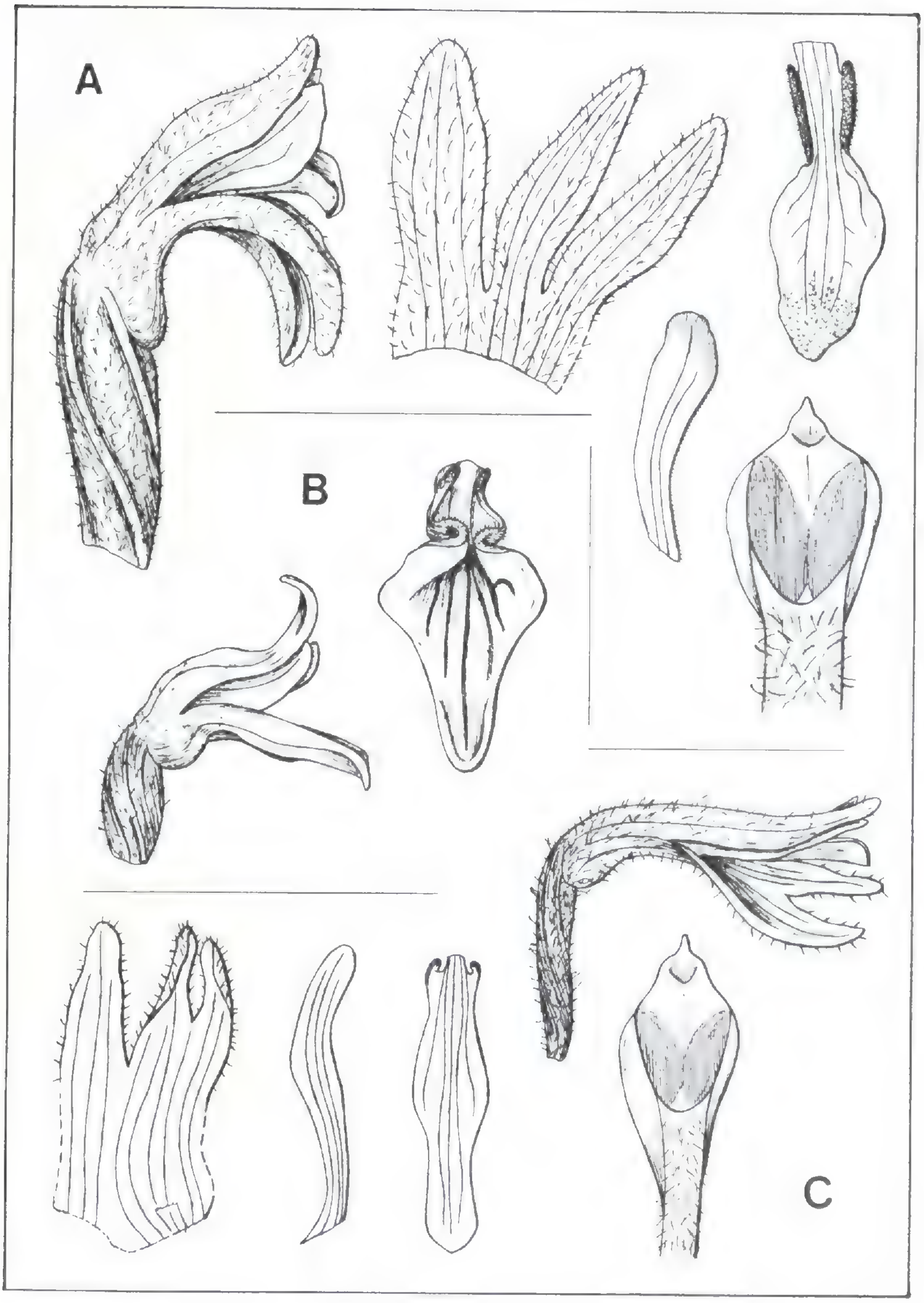

Plate 31.

A. **Kionophyton seminuda** (Schltr.) Garay. Type.
B. **Kionophyton pyramidalis** (Lindl.) Garay.
C. **Kionophyton Sawyeri** (Standl. & L.O.Wms.) Garay.

PLATE 32

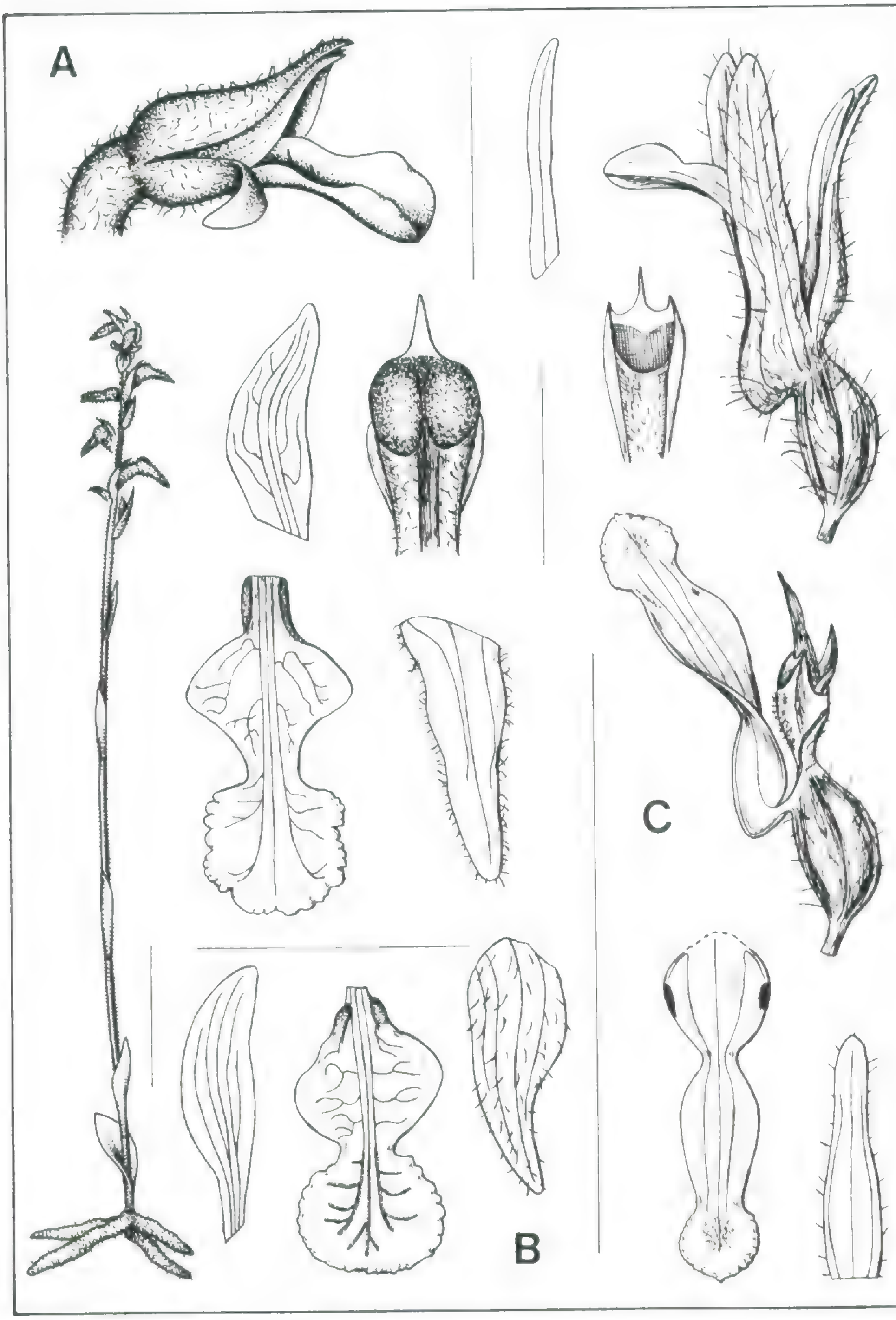

Plate 32.

A. **Lyroglossa Grisebachii** (Cogn.) Schltr. (Type of Spiranthes euglossa Krzl.)

B. **Lyroglossa pubicaulis** (L.O.Wms.) Garay. Type.

C. **Lankesterella caespitosa** (Lindl.) Hoehne. Type.

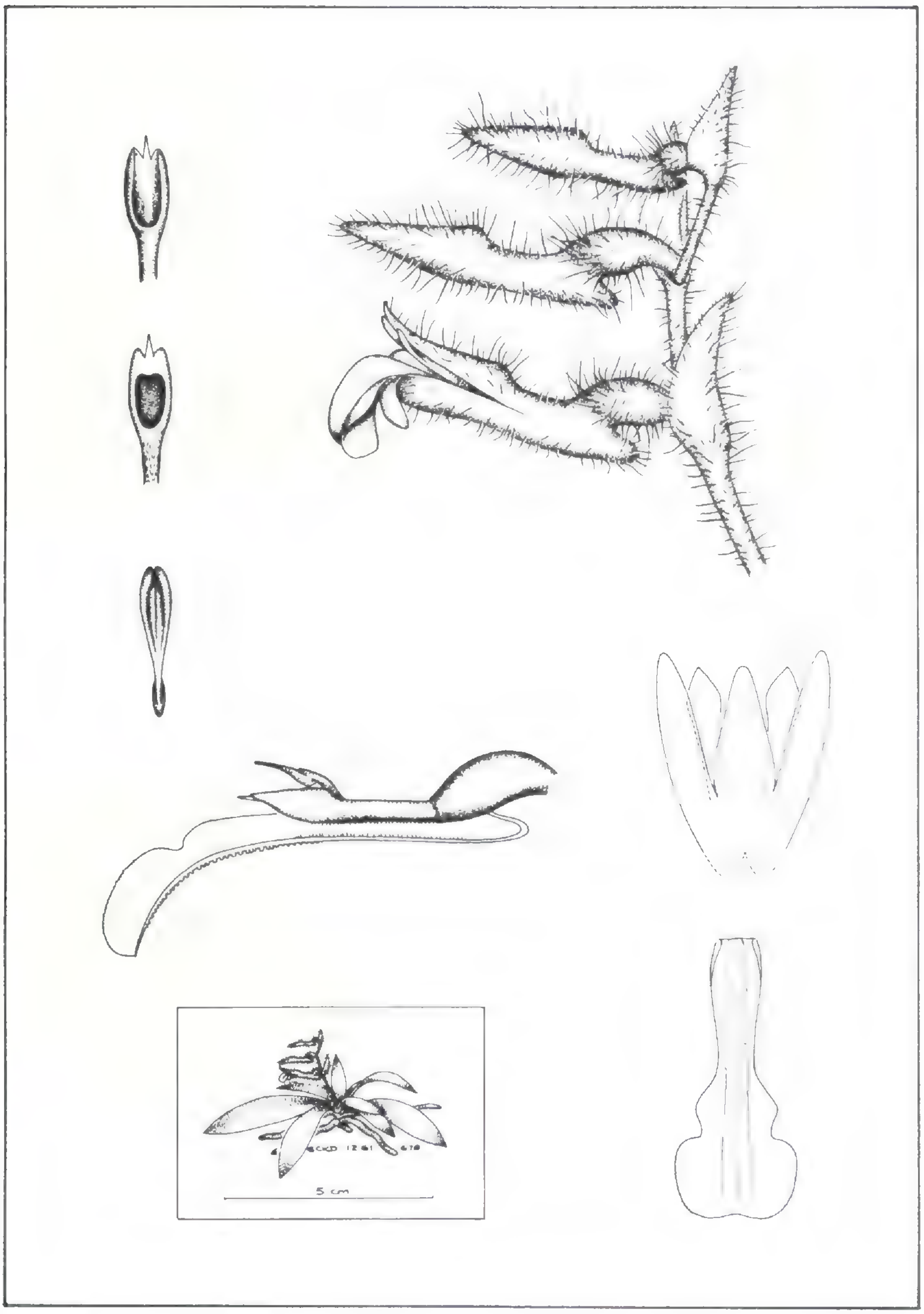

Plate 33.
Lankesterella ceracifolia (Barb.Rodr.) Mansf.

PLATE 34

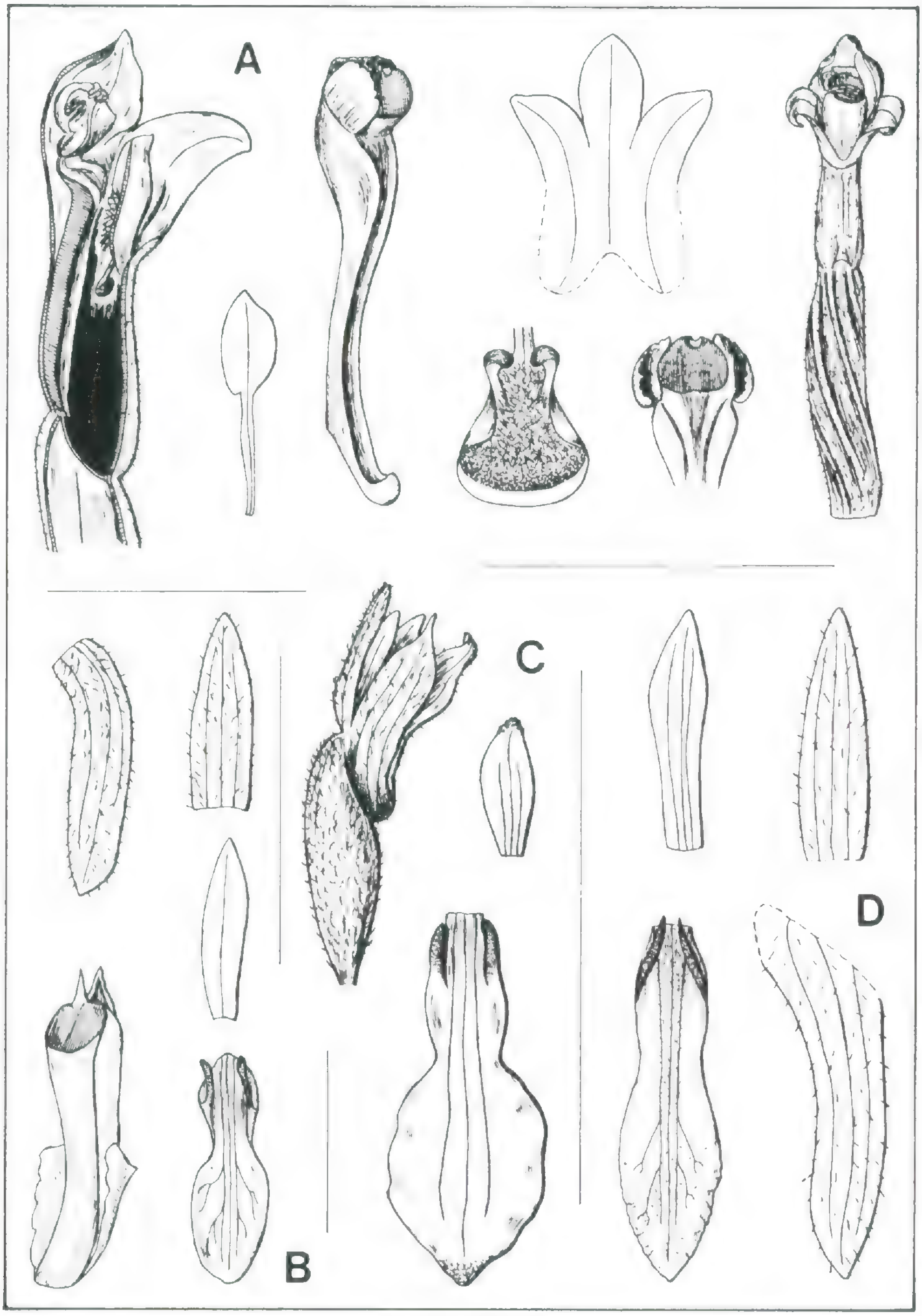

Plate 34.

A. **Manniella Gustavii** Rchb.f. Type.
B. **Mesadenella peruviana** Garay. Type.
C. **Mesadenella cuspidata** (Lindl.) Garay. Type.
D. **Mesadenella angustisegmenta** Garay. Type.

PLATE 35

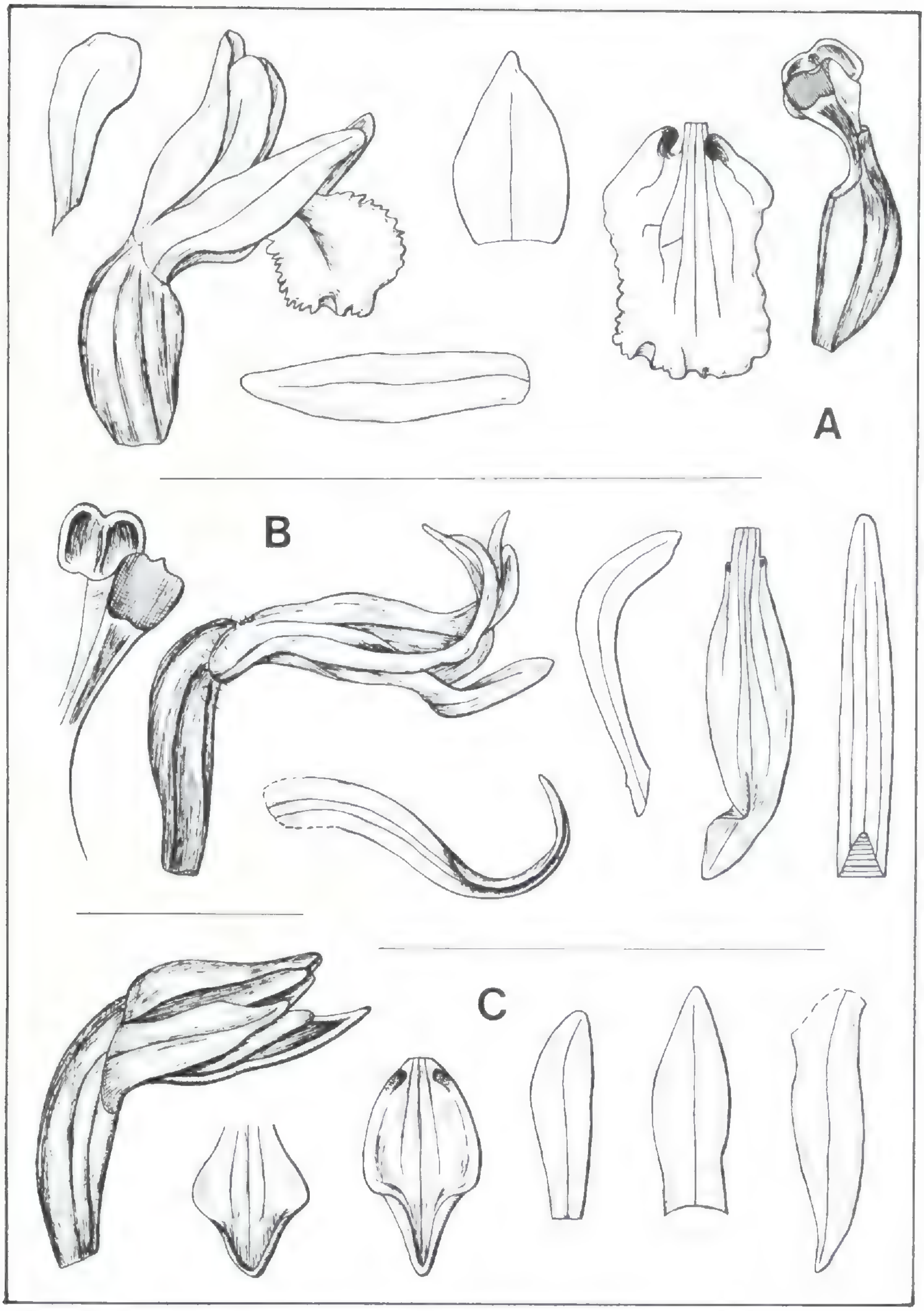

Plate 35.

A. **Mesadenus affinis** (C. Schweinf.) Garay. Type.
B. **Mesadenus lucayanus** (Britt.) Schltr. Type.
C. **Mesadenus rhomboglossus** (Pabst) Garay. Type.

PLATE 36

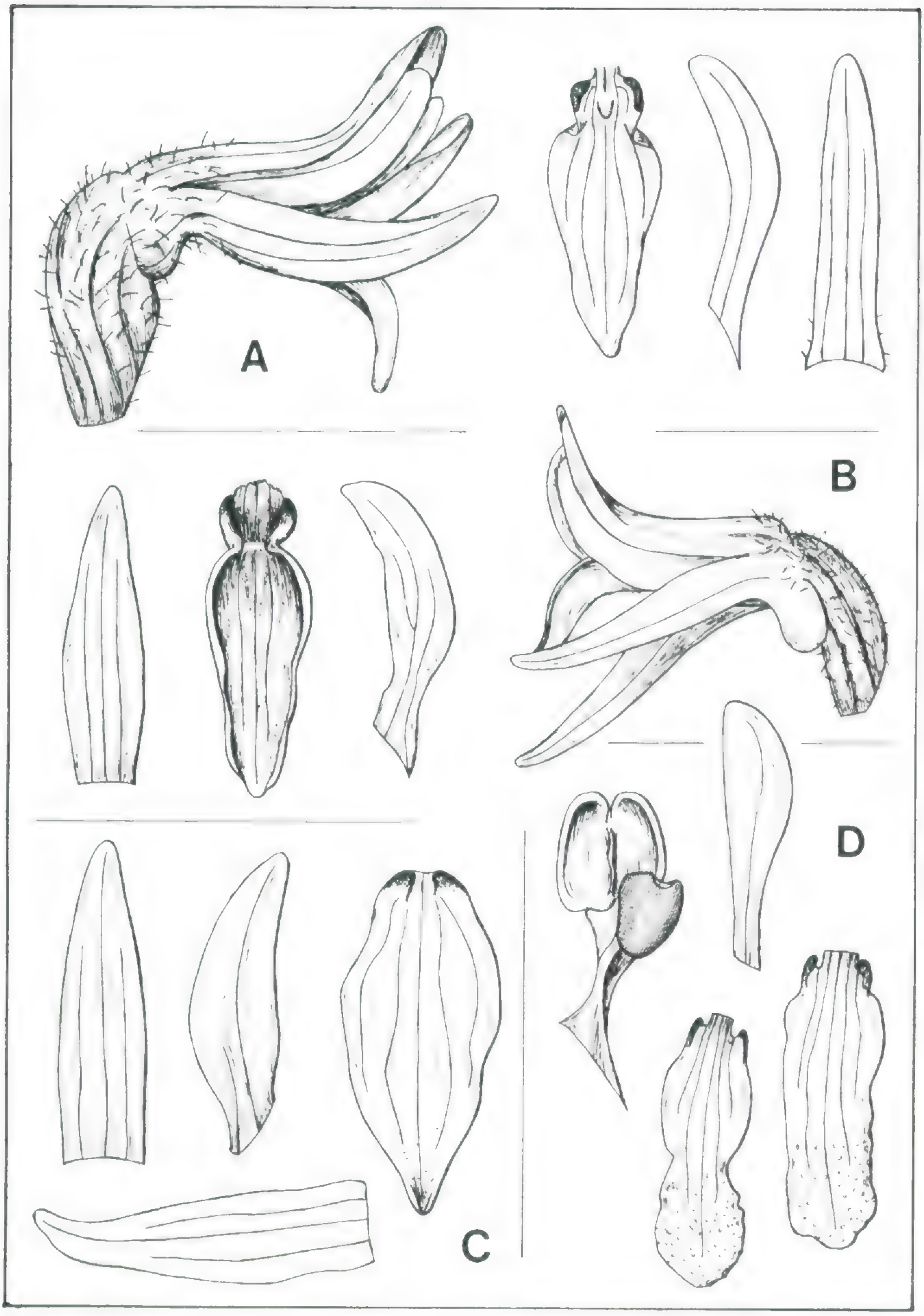

Plate 36.

A. **Mesadenus Chiangii** (Johnst.) Garay. Type.
B. **Mesadenus Glaziovii** (Cogn.) Schltr.
C. **Mesadenus Stahlii** (Cogn.) Garay. Type.
D. **Mesadenus tenuissimus** (L.O.Wms.) Garay. Type.

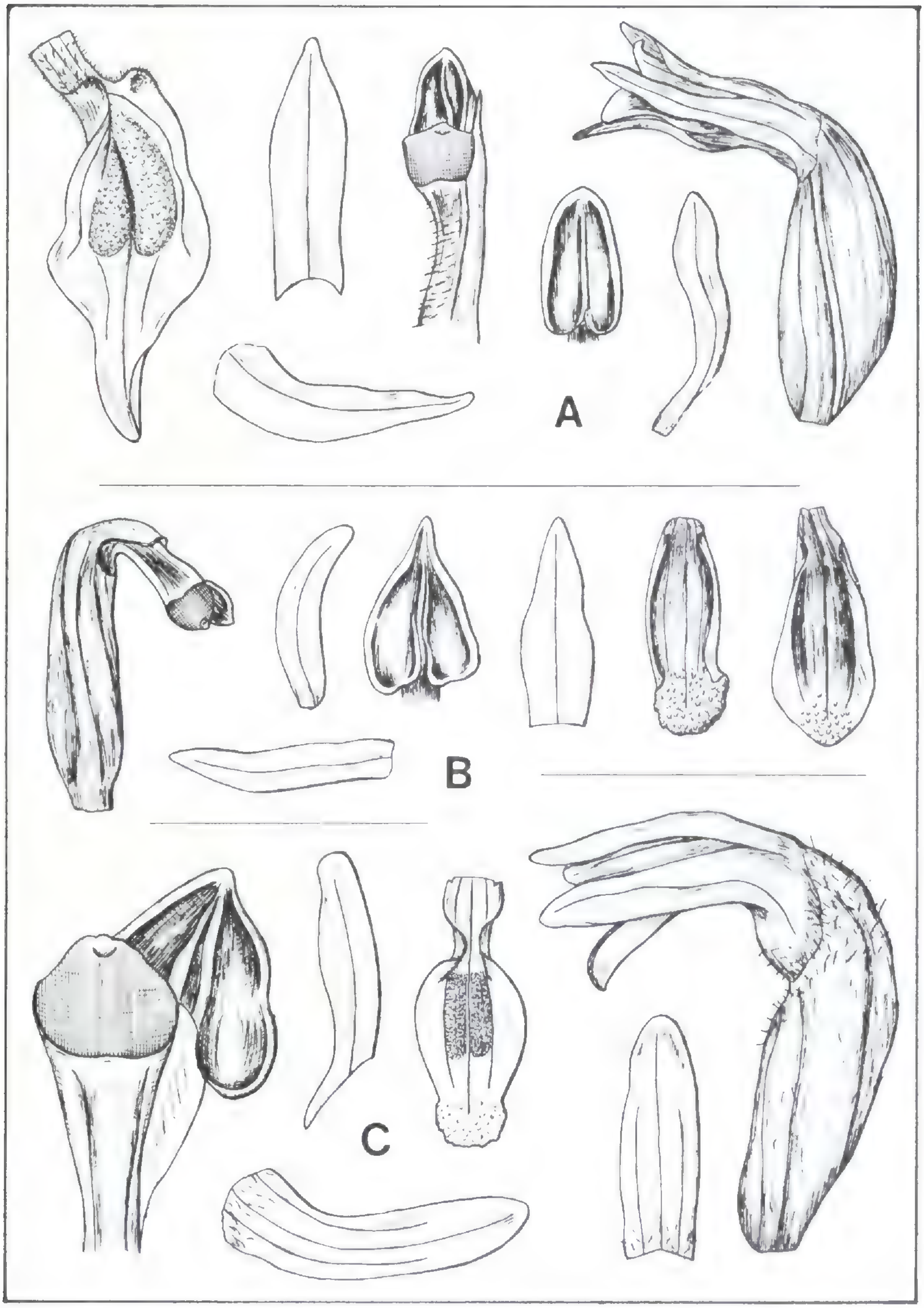

Plate 37.

A. **Microthelys minutiflora** (Rich. & Gal.) Garay.
B. **Microthelys nutantiflora** (Schltr.) Garay.
C. **Microthelys rubrocallosa** (Robins. & Greenm.) Garay. Type.

PLATE 38

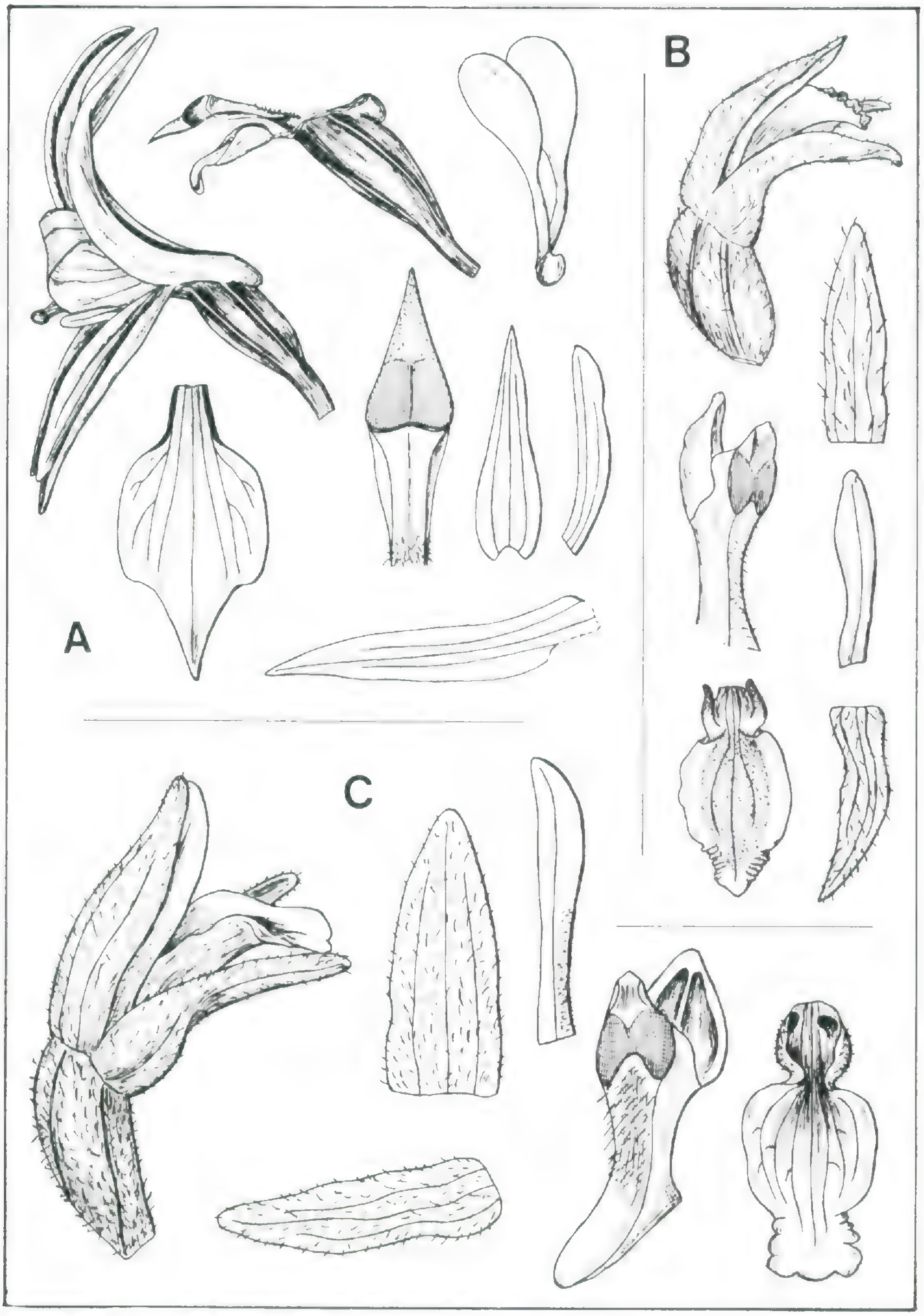

Plate 38.

A. **Nothostele acianthiformis** (Rchb.f. & Warm.) Garay.

B. **Odontorhynchus chlorops** (Rchb.f.) Garay. (Type of Spiranthes Bangii Rolfe.)

C. **Odontorhynchus alticola** Garay. Type.

PLATE 39

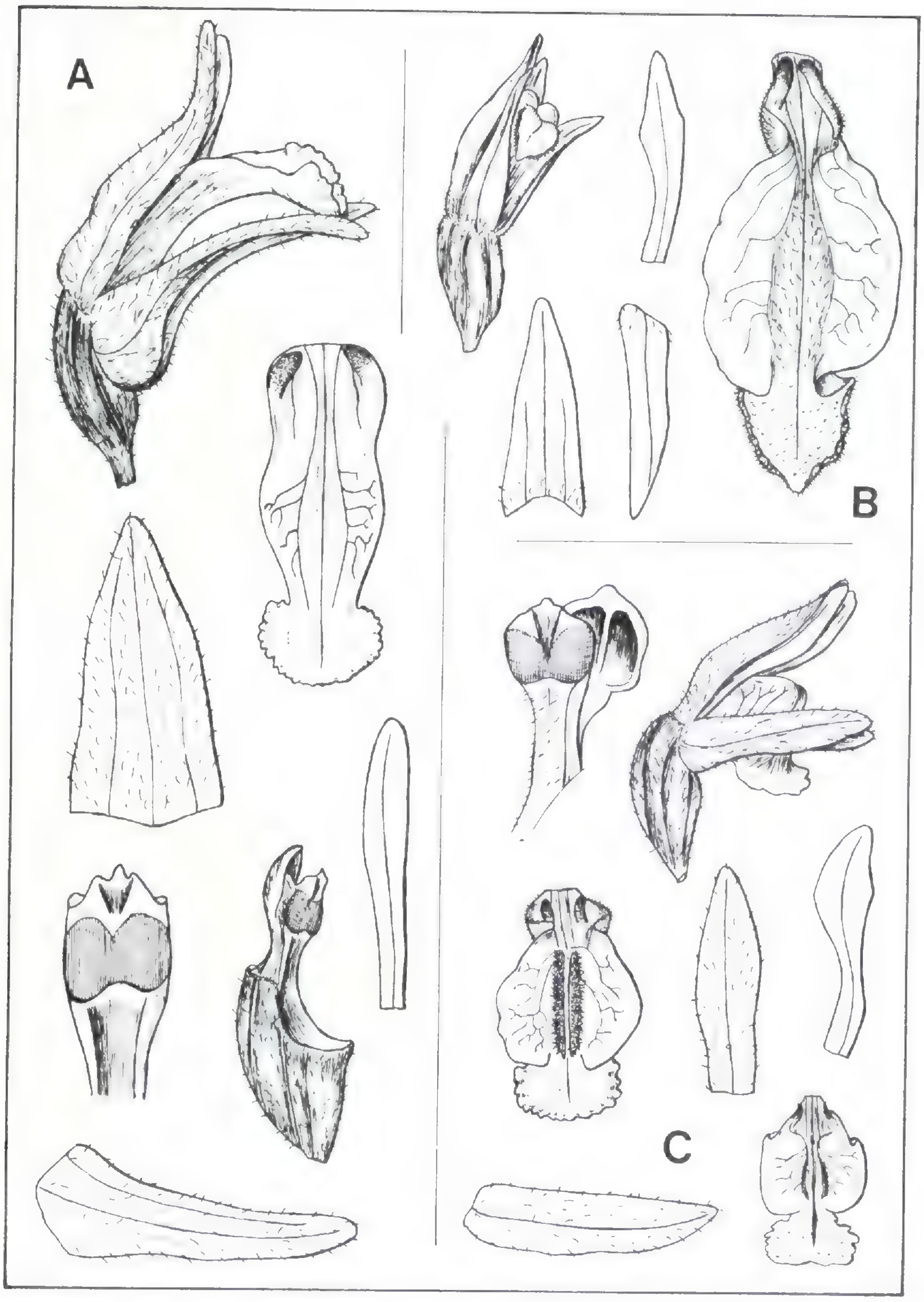

Plate 39.

A. **Odontorhynchus Castillonii** (Haum.) Correa. Type.
B. **Odontorhynchus chilensis** (A. Rich.) Garay.
C. **Odontorhynchus variabilis** Garay. Type.

PLATE 40

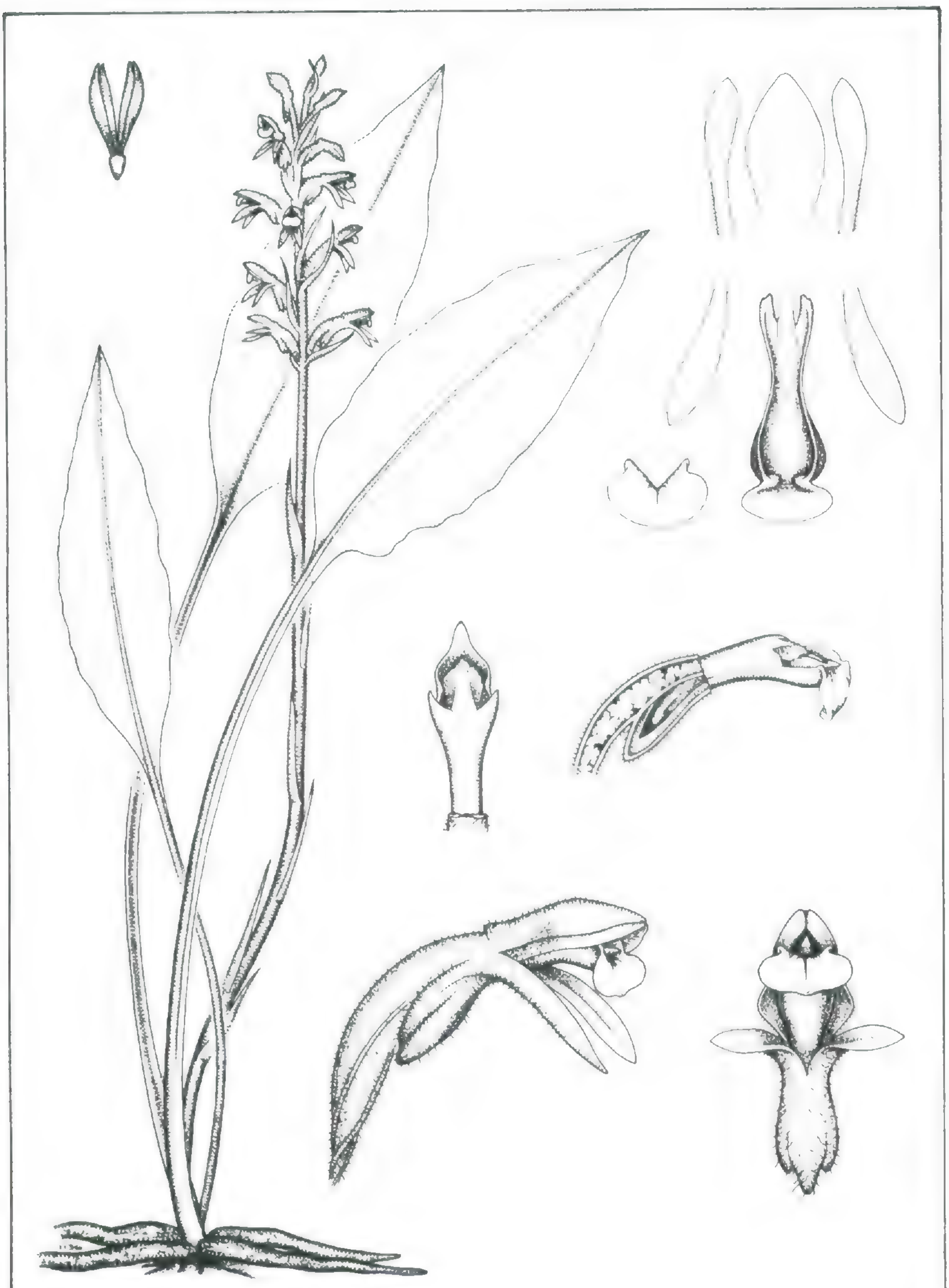

Plate 40.
Pelexia novofriburgensis (Rchb.f.) Garay.

PLATE 41

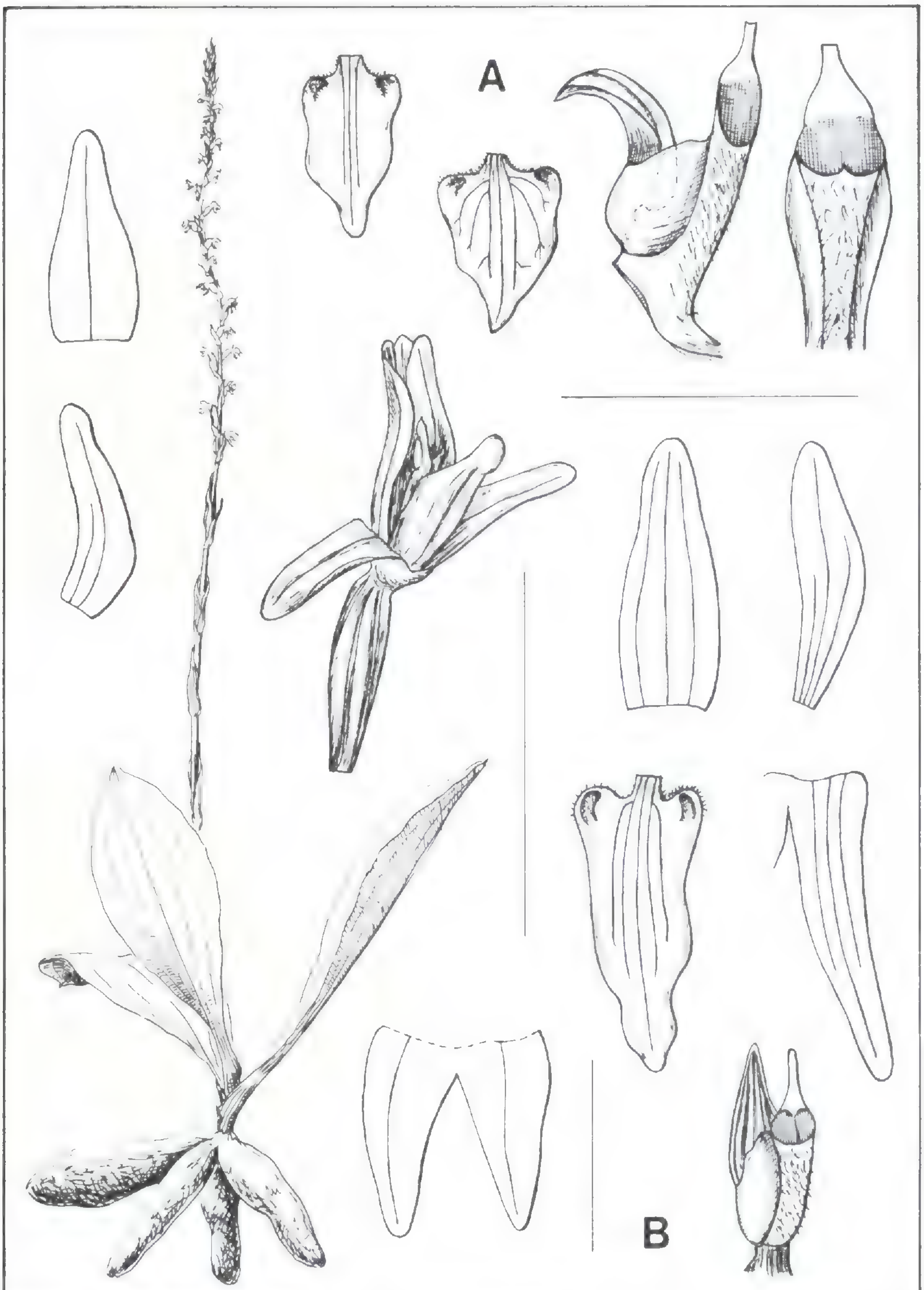

Plate 41.
A. **Physogyne Gonzalesii** (L.O.Wms.) Garay. Type.
B. **Physogyne sparsiflora** (C. Schweinf.) Garay. Type.

PLATE 42

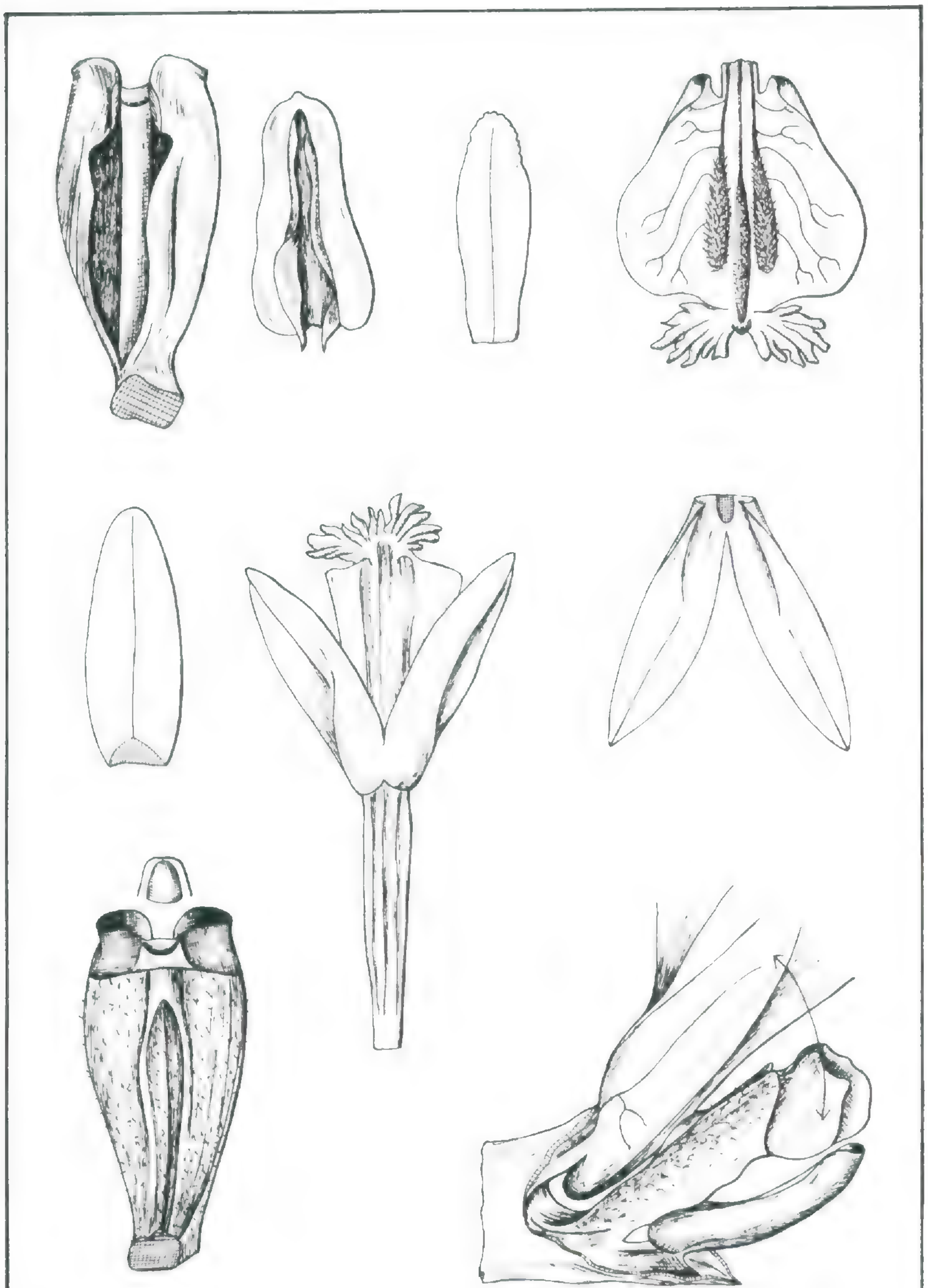

Plate 42.
Pseudocranichis thysanochila (Robins. & Greenm.) Garay. Type.

Plate 43.

A. **Pseudogoodyera Wrightii** (Rchb.f.) Schltr. Type.

B. **Pteroglossa luteola** Garay. Type.

PLATE 44

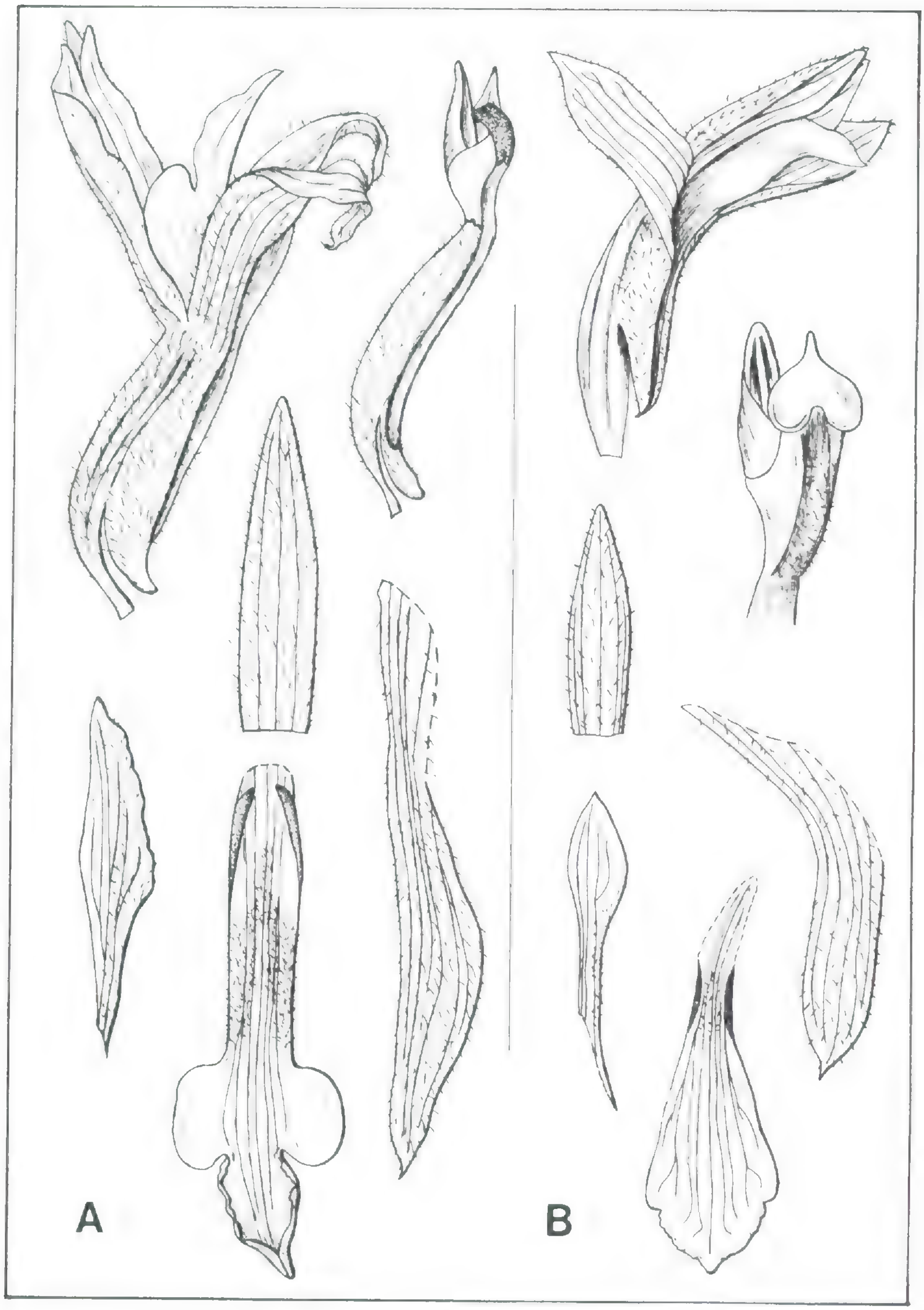

Plate 44.

A. **Pteroglossa macrantha** (Rchb.f.) Schltr.
B. **Pteroglossa rhombipetala** Garay. Type.

PLATE 45

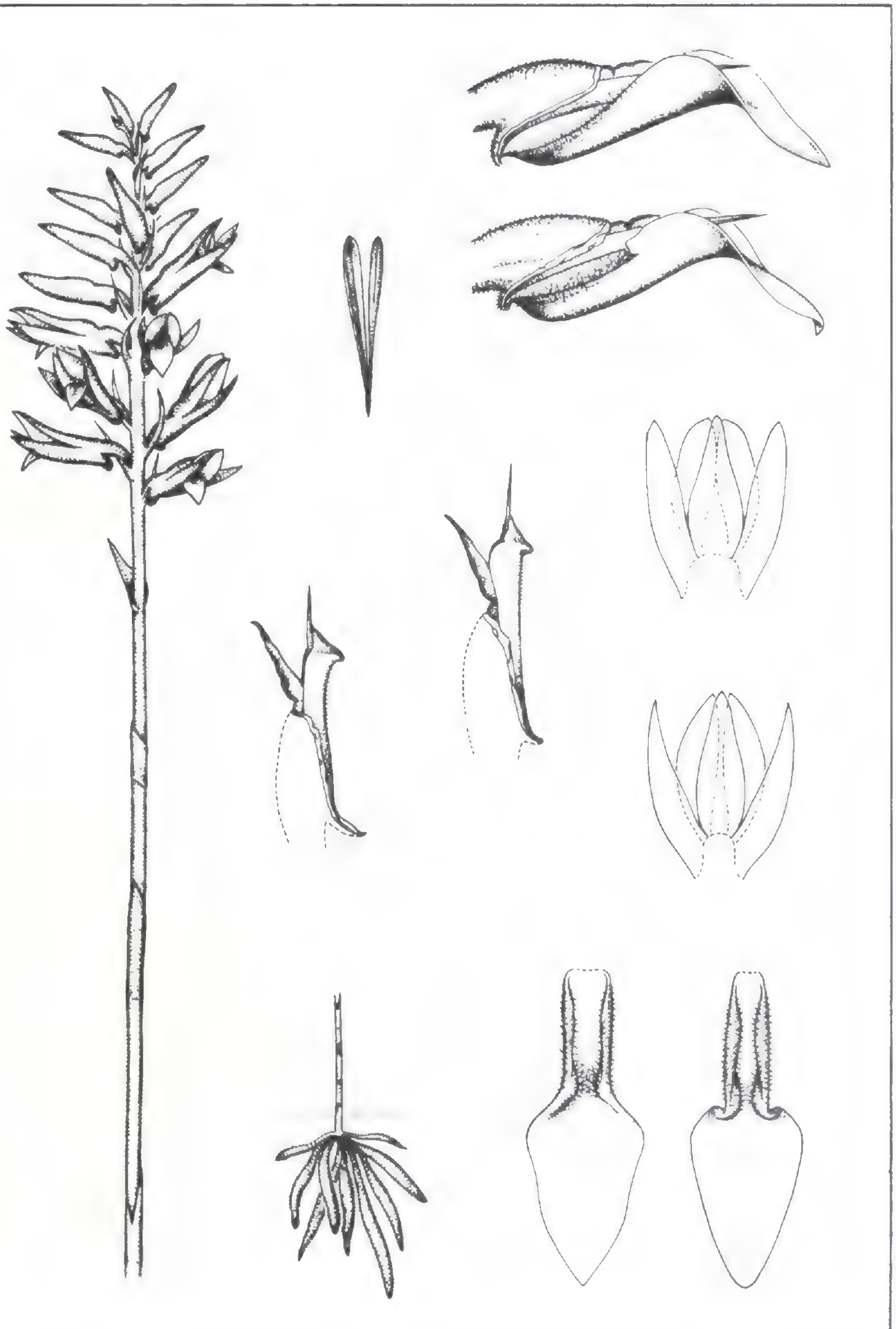

Plate 45.
Sacoila lanceolata (Aubl.) Garay.

PLATE 46

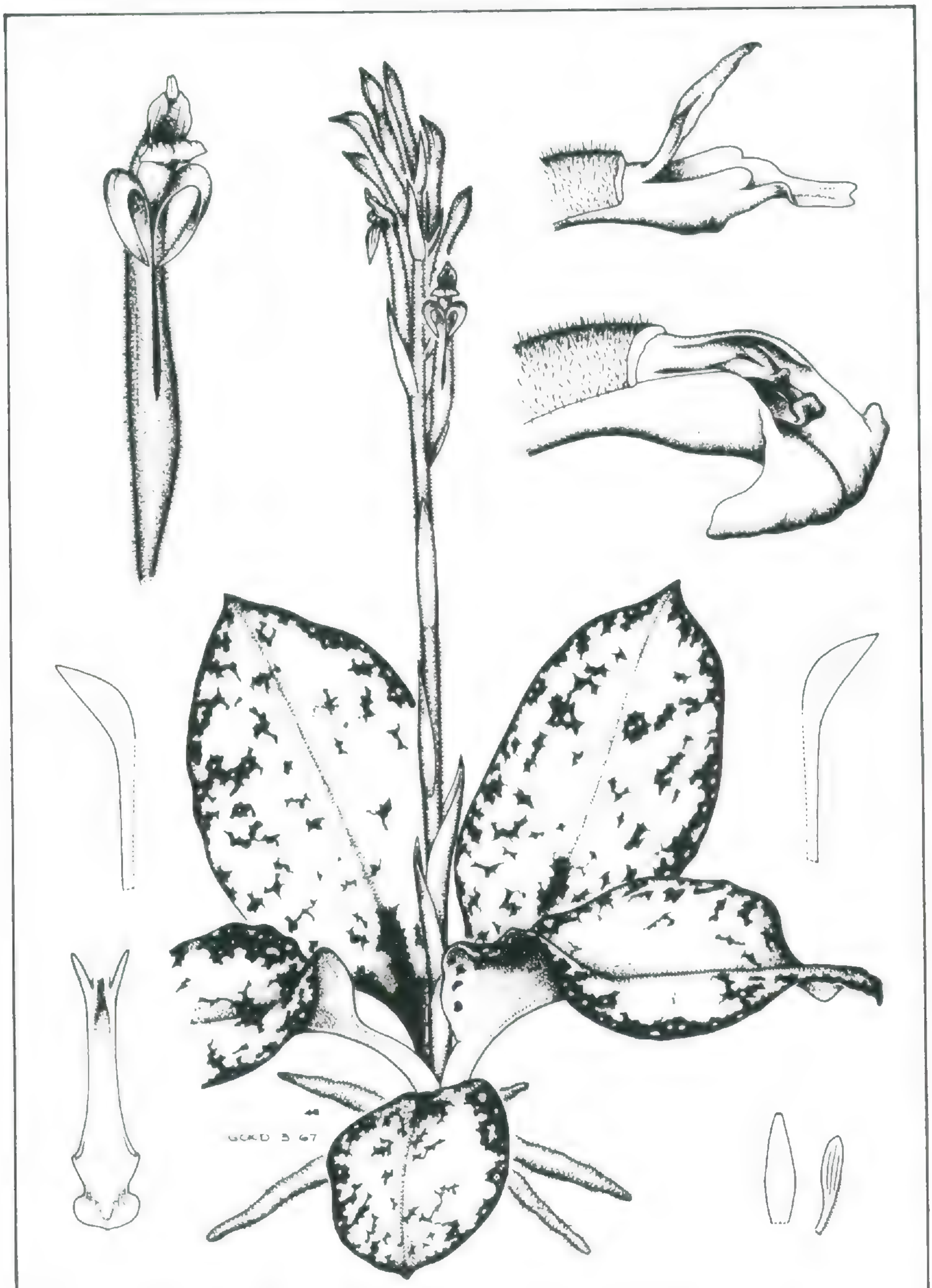

Plate 46.

Sarcoglottis acaulis (J.E.Sm.) Schltr.

PLATE 47

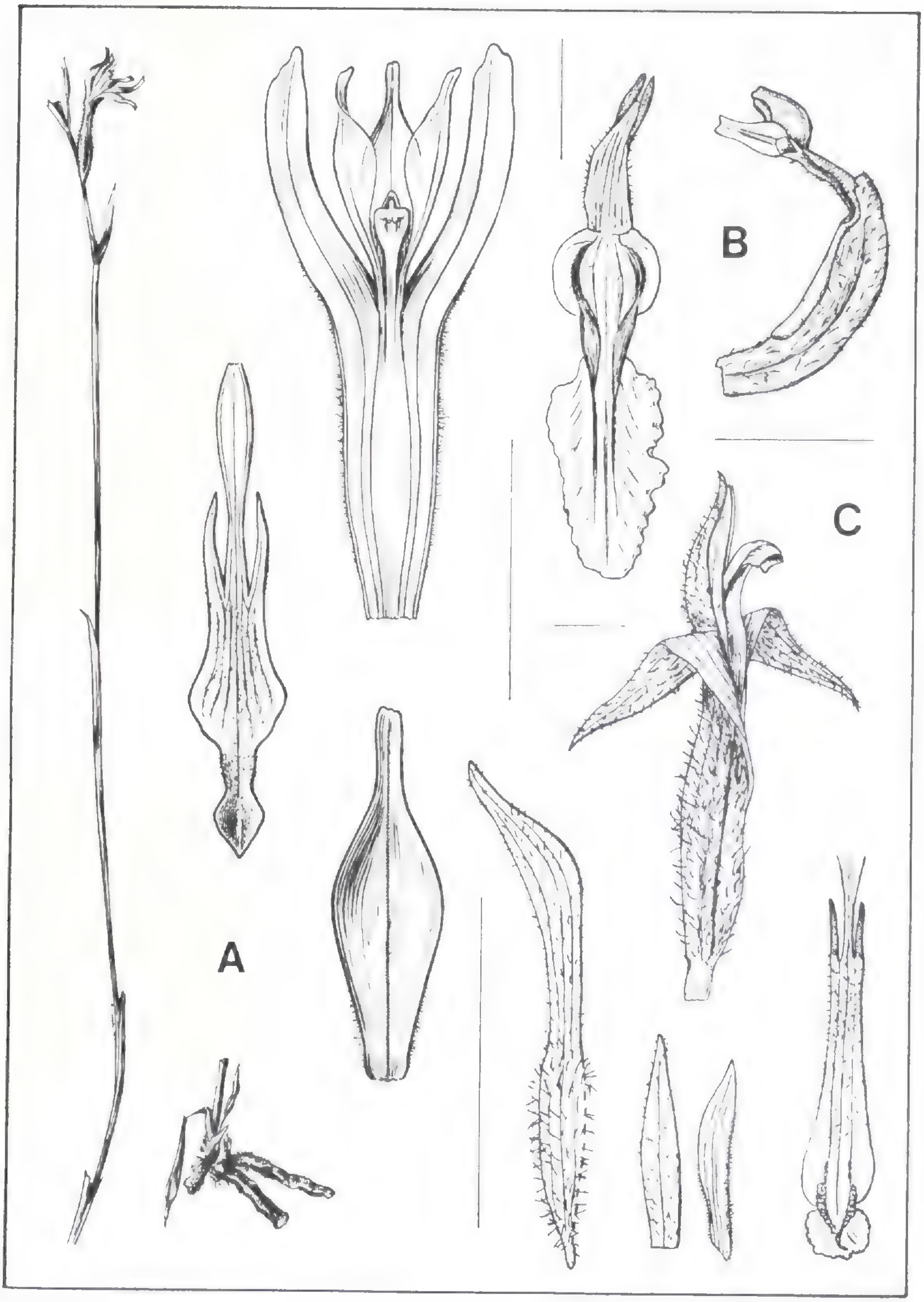

Plate 47.

A. **Sarcoglottis simplex** (Griseb.) Schltr. (Type of Spiranthes longiauriculata C. Schweinf.)
B. **Sarcoglottis homalogastra** (Rchb.f. & Warm.) Schltr.
C. **Sarcoglottis Woodsonii** (L.O.Wms.) Garay. Type.

PLATE 48

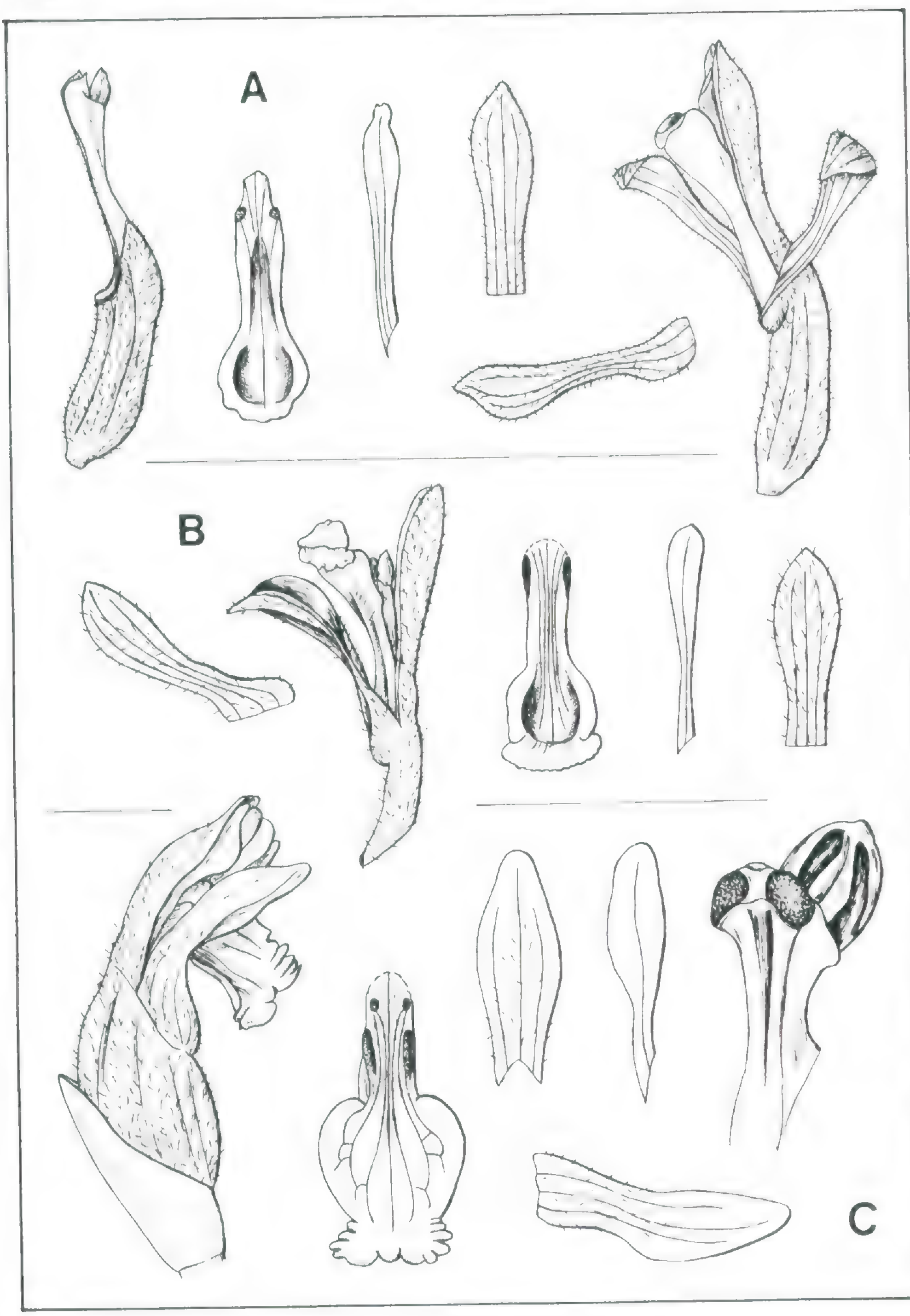

Plate 48.

A. **Sauroglossum elatum** Lindl. Type.
B. **Sauroglossum andinum** (Haum.) Garay. Type.
C. **Sauroglossum Schweinfurthianum** Garay. Type.

PLATE 49

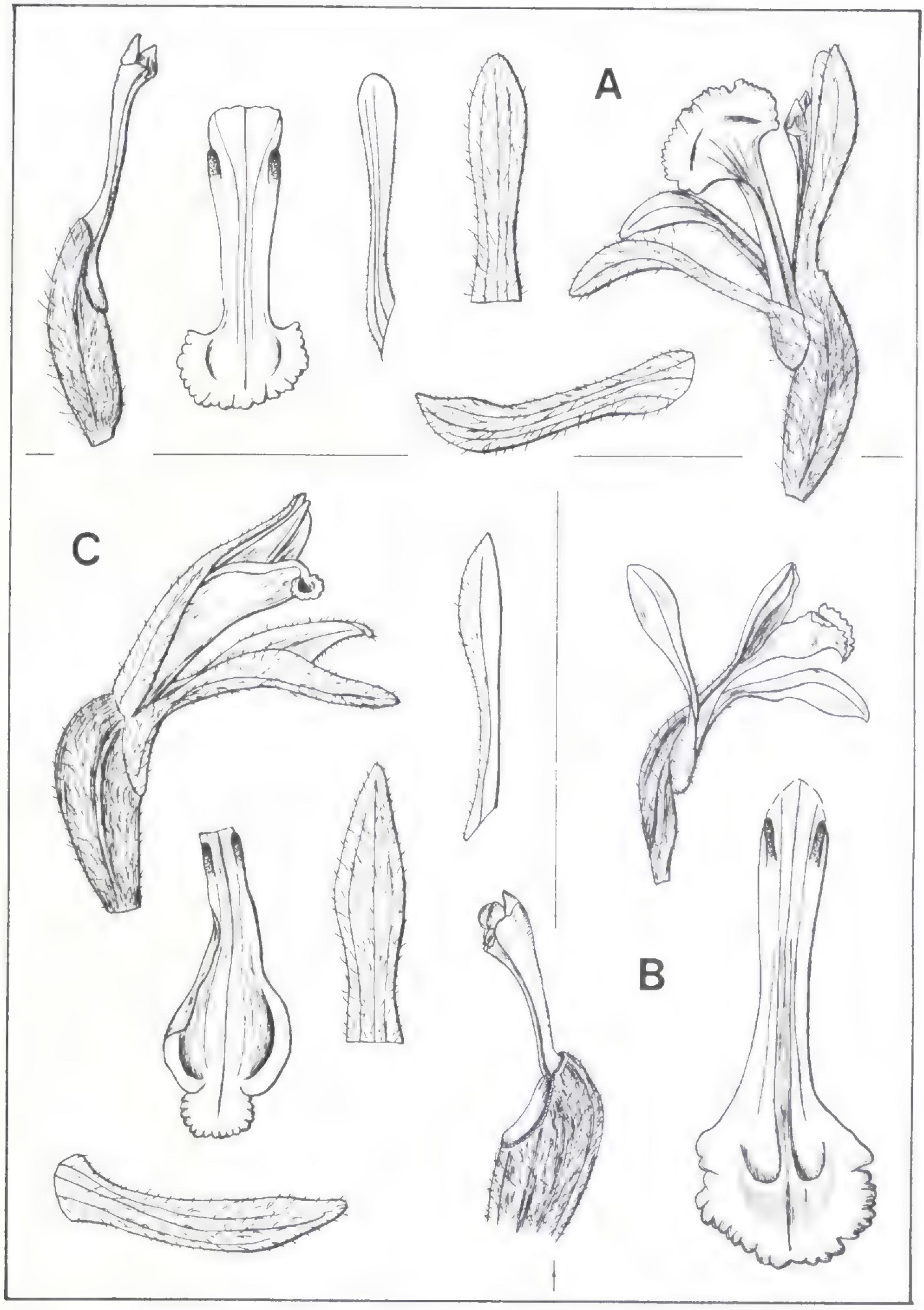

Plate 49.

A. **Sauroglossum aurantiacum** (C.Schweinf.) Garay. Type.
B. **Sauroglossum corymbosum** (Lindl.) Garay. Type.
C. **Sauroglossum sellilabre** (Griseb.) Schltr. Type.

PLATE 50

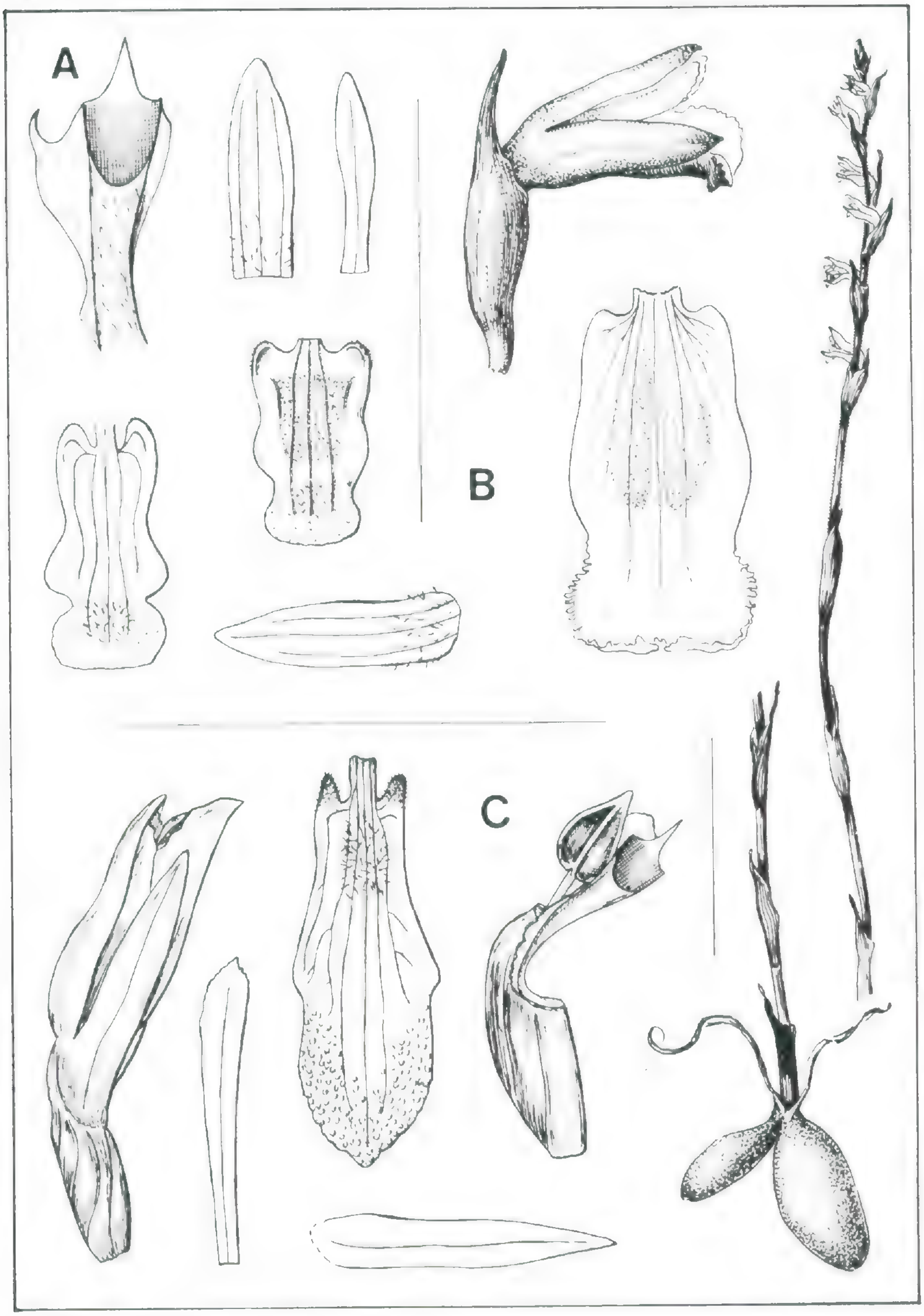

Plate 50.

A. **Schiedeella Amesiana** Garay. Type.
B. **Schiedeella parasitica** (Rich. & Gal.) Schltr.
C. **Schiedeella Llaveana** (Lindl.) Schltr. Type.

PLATE 51

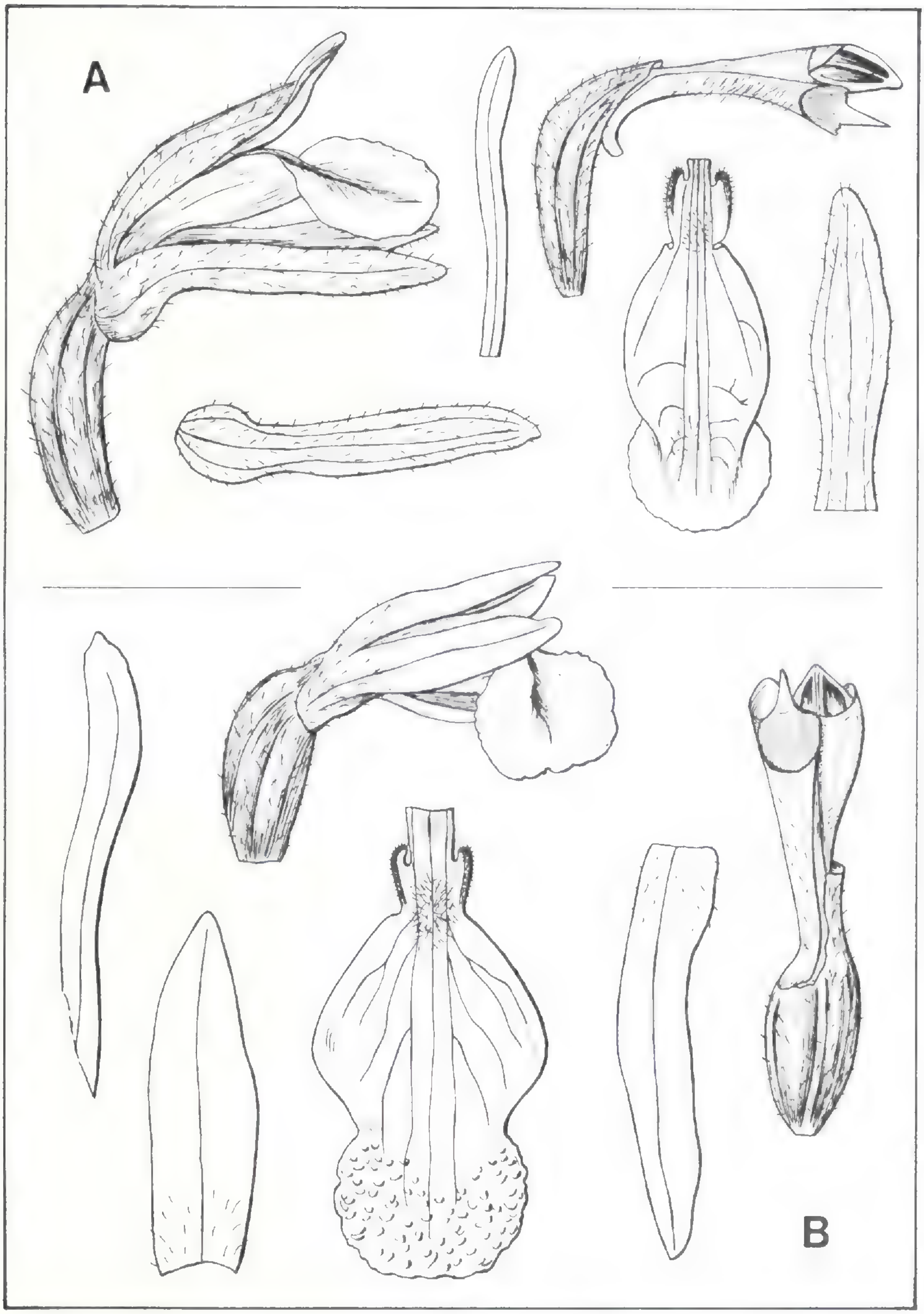

Plate 51.

A. **Schiedeella Nagelii** (L.O.Wms.) Garay. Type.
B. **Schiedeella violacea** (Rich. & Gal.) Garay

PLATE 52

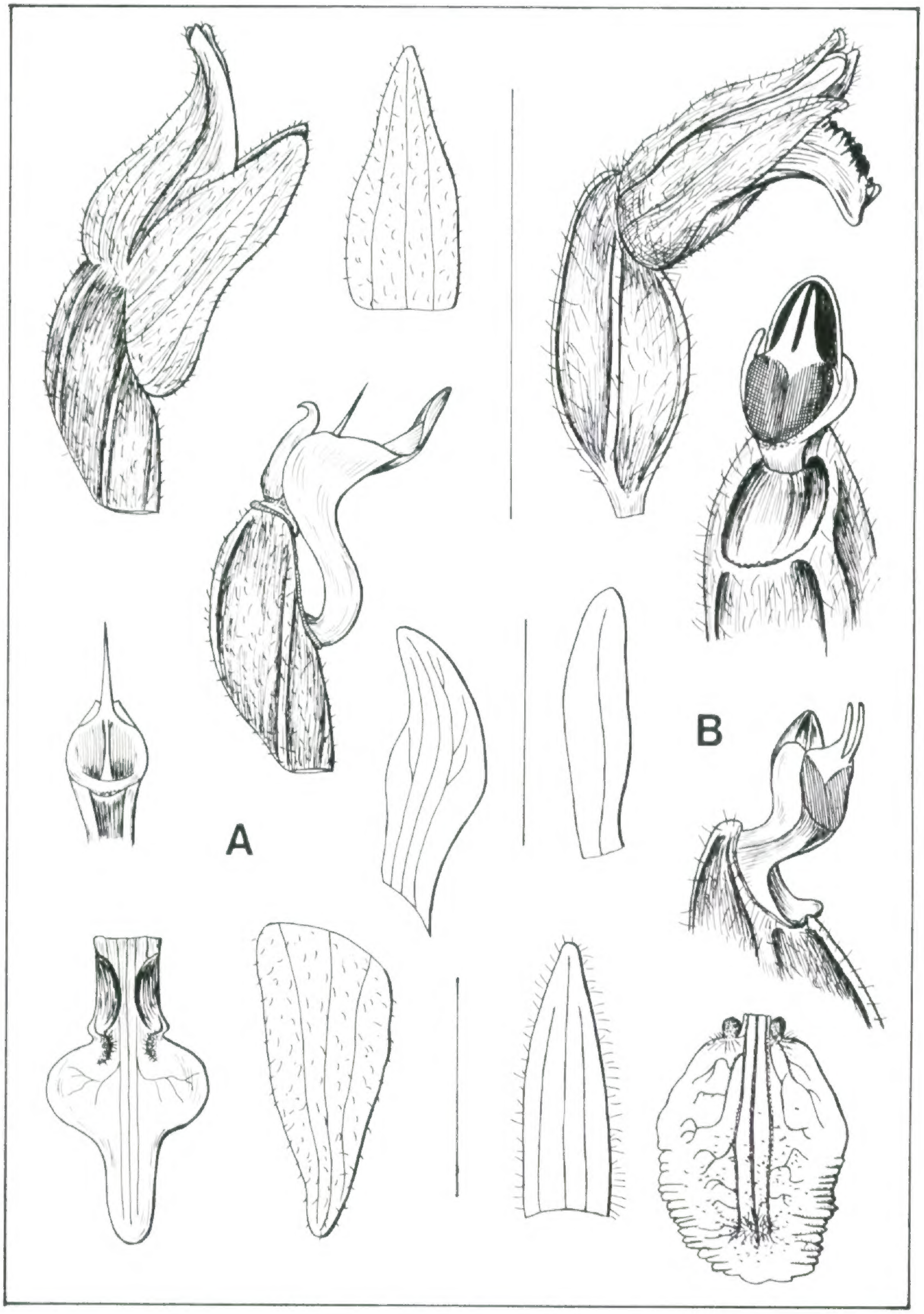

Plate 52.

A. **Skeptrostachys rupestris** (Lindl.) Garay. Type.
B. **Spiranthes spiralis** (L.) Chevall.

PLATE 53

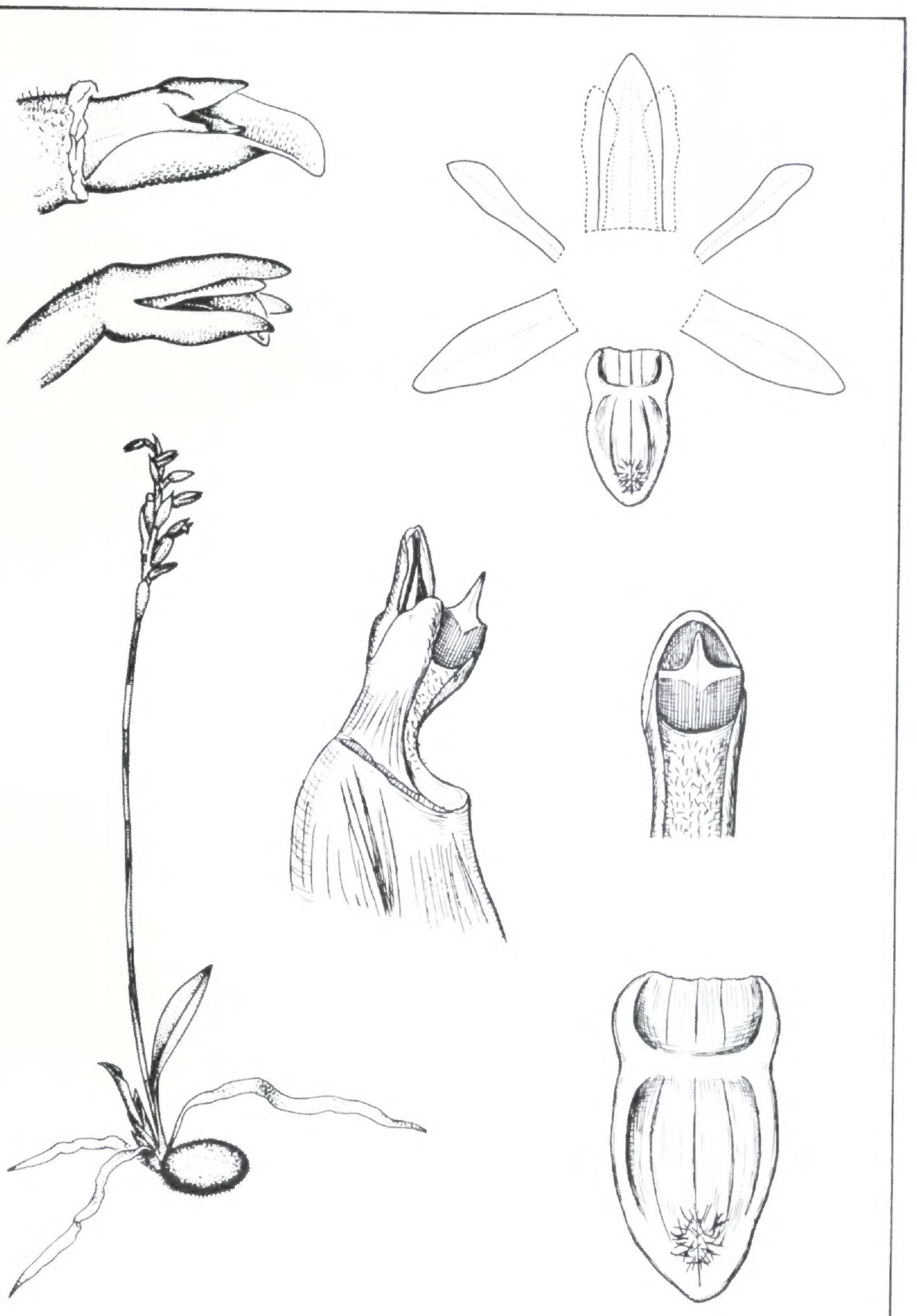

Plate 53.

Stalkya muscicola (Garay & Dunsterv.) Garay. Type.

PLATE 54

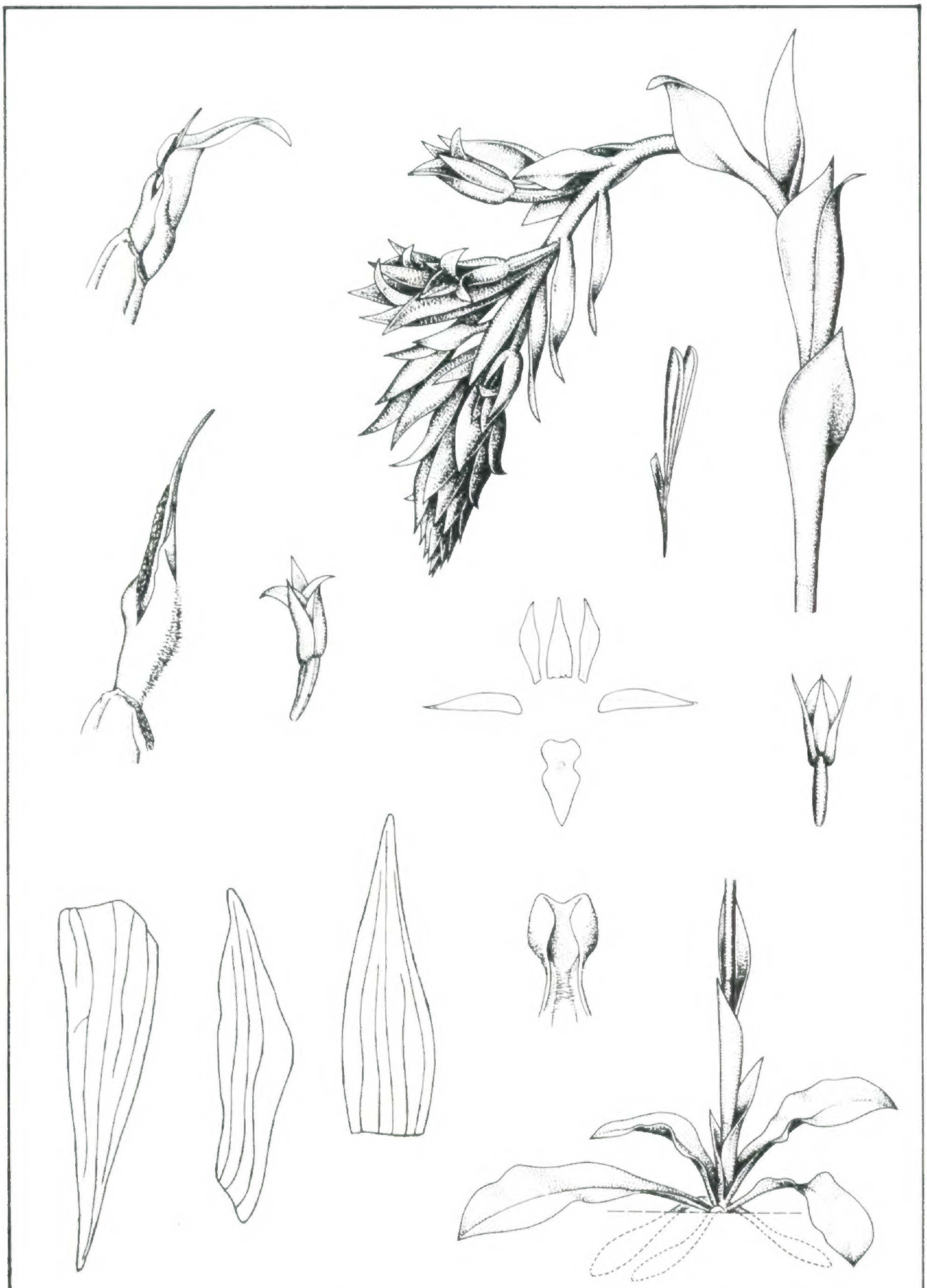

Plate 54.
Stenorrhynchos nutans Kunth & Bouché

PLATE 55

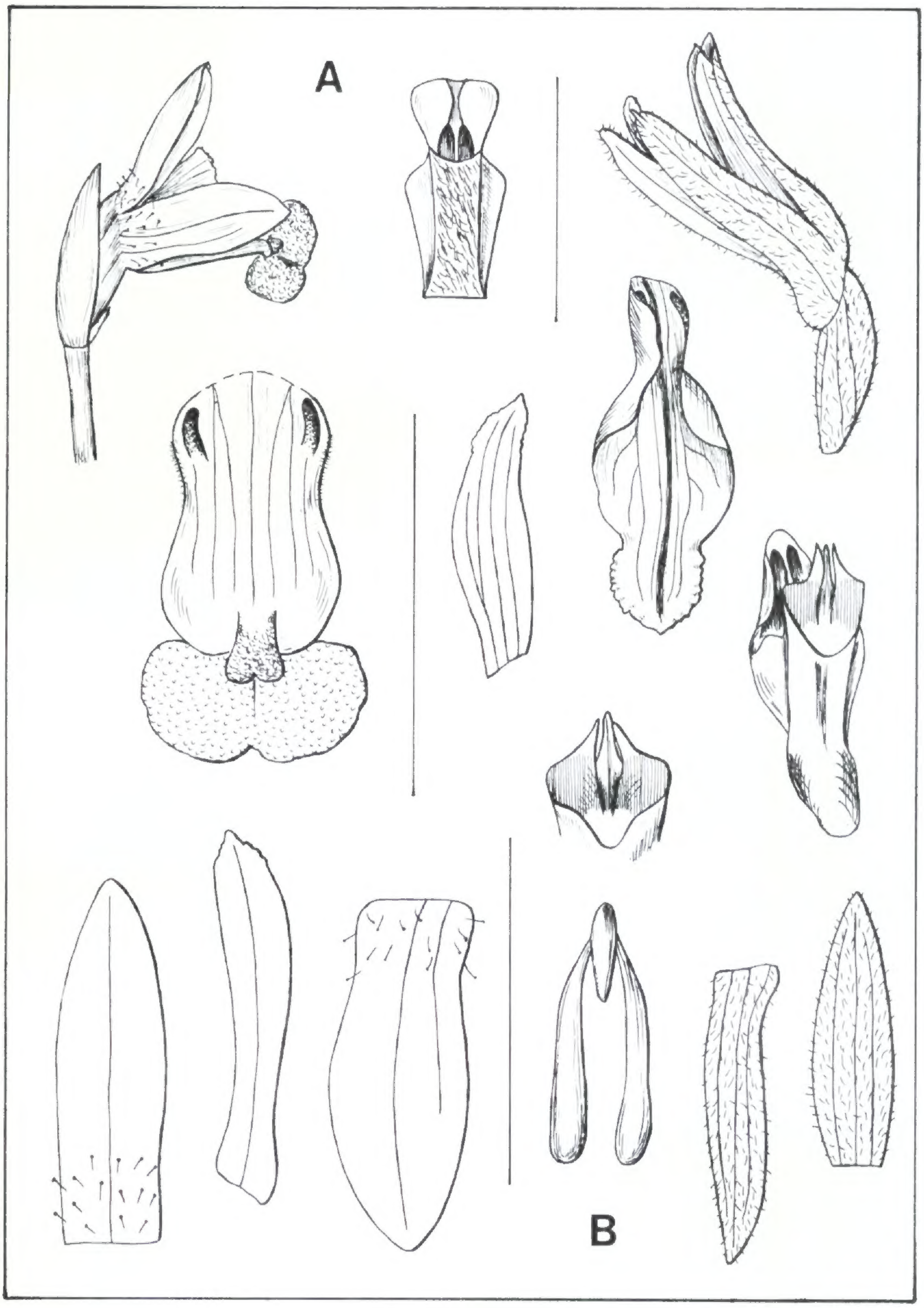

Plate 55.

A. **Stigmatosema Hatschbachii** (Pabst) Garay. Type.
B. **Thelyschista Ghillanyi** (Pabst) Garay. Type.